THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY—VOL. XXI.

TEXT.

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND THE LATE

CAPTAIN FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF

THE LATE

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DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD

AND NOW OF

JOHN MURRAY

ONE OF THE NATURALISTS OF THE EXPEDITION

ZOOLOGY—VOL. XXI.

TEXT

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By Dr. F. E. Schulze, Professor of Zoology in the University of Berlin.

TEXT.

EDITORIAL NOTE.

The Report on the Hexactinellida, by Professor F. E. Schulze of the University of Berlin, occupies the whole of the present Volume, the Text and Plates being bound up in separate parts. This Report forms Part LIII. of the Zoological Series of Reports on the Scientific Results of the Expedition; it extends to over 500 pages and is illustrated by 104 Lithographic Plates and many woodcuts.

Sir C. Wyville Thomson gave special attention to this group of Sponges during the Expedition, and it was his intention to describe them in detail in these Official Reports. Owing, however, to ill health and other circumstances he was never able seriously to commence the work, and at the time of his death there remained only a few Plates which had been prepared under his directions.

It must be regarded as a singularly fortunate circumstance that I was, in 1882, able to induce so eminent a Spongiologist as Professor Schulze to undertake the examination and description of this most characteristic deep-sea group of animals, to which he had already given special attention. The result of Professor Schulze's labours is presented in this magnificent Monograph, which will be welcomed by naturalists in all parts of the world as a substantial and brilliant addition to our scientific knowledge.

Some portions of the German manuscript were translated by Mr. John Rattray, M.A., B.Sc., F.R.S.E., but by far the larger part was translated by Mr. Arthur Thomson, M.A., F.R.S.E., and the whole was revised by him.

The Manuscript was received by me in instalments between the 10th August 1886 and the 30th May 1887.

John Murray.

Challenger Office, 32 Queen Street,
Edinburgh, 1*st August* 1887.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the Hexactinellida collected by H.M.S. Challenger during the Years 1873–76. By Dr. F. E. Schulze, Professor of Zoology in the University of Berlin.

PREFACE AND HISTORY OF THE WORK.

In December 1879, I was asked by Sir Wyville Thomson to examine some specimens of *Euplectella aspergillum*, which had been procured on the Challenger Expedition, and which had been preserved with special care for histological purposes. The results of my investigation were to be published as part of the Report of the Challenger Expedition. Though at that time engaged in the study of the Adriatic Sponges I did not hesitate to concur with the request, as I was strongly attracted by the prospect of being able to study the hitherto almost unknown soft structure of the Hexactinellida. I soon received, from the Challenger office in Edinburgh, an entire specimen of *Euplectella aspergillum* (from off Zebu), preserved with its soft parts in methylated spirit, and six bottles containing fragments of the same species preserved in absolute alcohol, or in other preservative media, such as chromic acid, picric acid, acetate of potash, glycerine, &c.

After the results of my investigation of this, in part, well preserved material had been published in the Transactions of the Royal Society of Edinburgh (1880, vol. xxix. p. 661, Tab. A), Sir Wyville Thomson asked me to work over with him all the Hexactinellida obtained during the expedition. He was to undertake the study of the skeletal structures, while the investigation of the soft parts was to be entrusted to me. To this I readily agreed, and began at once with the examination of some samples, which had been previously sent to me at Graz.

This pleasant arrangement for joint research was, however, frustrated by the illness and death of Sir Wyville Thomson. I had, accordingly, to lay aside the whole work for a prolonged period, till, in March 1882, Mr. John Murray asked me to undertake the complete investigation of the Challenger Hexactinellida, and for this purpose, in the first instance, personally to undertake the separation of the latter from the rich collection of Sponges obtained during the expedition and preserved in Edinburgh. Having completed this in April of the same year, I received, in June, most of the Hexactinellida collected by the Challenger Expedition, which were forwarded to me at Graz in a well-packed condition. Subsequently, at my request, a few additional Hexactinellida, which were collected before by Sir Wyville Thomson and Mr. John Murray in the eastern part of the Atlantic, during the expeditions of the "Lightning," "Porcupine," "Knight Errant," and "Triton," were handed over to me for purposes of comparison, and also a number of microscopic preparations which had been made by Sir Wyville Thomson.

My material was afterwards very agreeably increased by the acquisition of a not unimportant collection of Hexactinellida, partly dry and partly preserved in alcohol, which Dr. Döderlein, Director of the Zoological Museum in Strassburg, had accumulated during a prolonged stay in Japan, partly as the result of his own collecting on the small island of Enoshima. This collection he very kindly placed at my disposal for investigation.

At my request the Challenger Commission agreed that I should include this valuable material in my work on the Challenger Hexactinellida, and approved of what thus necessarily involved an increase of plates. I therefore accepted the offer of Dr. Döderlein, and that all the more willingly since the increase of material considerably facilitated the systematic work. On the other hand, I was enabled to compare minutely a collection zealously and systematically made for several years from a definite locality remarkably rich in Hexactinellida, with that collected in the same locality by the Challenger Expedition.

As to the ways and means of acquiring this collection, which consisted of about twenty-five dried forms and three bottles of preserved specimens, Dr. Döderlein communicated to me the following notes:—"With the exception of a *Euplectella* (*oweni*) from Simonoseki on Kiushiu, the whole collection was gathered in Sagami Bay, near Enoshima. Most of the dried specimens were obtained from a shop in Enoshima, where they were collected for me by the owner. The three glasses with spirit contain specimens which I myself obtained with a trawling apparatus from depths varying from 80 to 240 fathoms, between Enoshima and Misaki. A few dead specimens which I obtained there have been sent dry. I have added a single specimen of *Hyalonema* (*sieboldii*) in which the sponge body is magnificently developed, but it is by no means the largest specimen which I brought with me."

Professor Oscar Schmidt of Strassburg was kind enough to hand over to me, for

a prolonged period, for purposes of comparison, portions of most of the Hexactinellida which he has described, and also a very large number of microscopical preparations. From Dr. Marshall of Leipzig I likewise obtained the use of portions and preparations of all the specimens which formed the basis of his own Hexactinellidan observations. I have been similarly assisted by Hofrath Director A. B. Meyer of Dresden, Professor Semper of Würzburg, Professor von Martens of Berlin, and Professor Moseley of Oxford. In the important work of determining forms, a visit which I paid to London was of much value, since, through the Challenger Expedition Commission, I was enabled to study the original specimens of several Hexactinellida described by Owen, Gray, Bowerbank, Carter, and others. During my work in London, not only were the rich treasures of the Museum made accessible to me in the most liberal way by Dr. Günther, Director of the Zoological Department of the British Museum, but I was also accommodated with a private work-room in the new building of the British Museum in South Kensington. There I enjoyed the most attentive and friendly assistance of Mr. S. O. Ridley.

I had valuable assistance of another kind from Dr. Vosmaer of Naples, who had the great kindness to place at my disposal the manuscript of that portion of his great Spongiological Bibliography (in course of preparation) which dealt with the Hexactinellida.

In the preparation of the numerous plates I have been ably helped by my assistant, Dr. von Mährenthal, who has photographed a number of objects, and by Mr. G. Firtsch, one of my students, who has executed numerous drawings from my sketches and according to my directions.

It is my pleasant duty to return my best thanks to all the gentlemen whom I have named, but especially to the Director of the Challenger Office, Mr. John Murray.

With regard to the figures given in the plates, I have still to note the following points. From the scientific papers belonging to Sir Wyville Thomson, sixteen lithographed plates have been handed over to me, all of which have been incorporated in the present work, viz., Pls. I., II., V., VII., VIII., IX., X., XV., XXXI., XXXV., XL., XLV., XLVI., LI., LXVI., and LXVII. As these had not yet been printed off when I received them, I was able to make several corrections, though I have preferred to leave most of them unaltered. Only from Pls. XXXI. and LXVII. a few figures have been removed, which represented spicules not really belonging to the Sponges figured. Every authority will admire the beautiful and life-like figures both of the entire Sponges and of the separate preparations which are found in Sir Wyville Thomson's plates. I was not able, however, to follow the method illustrated in these plates, since I could not confine myself merely to the general form of the Sponge, nor to the structure of the skeletal elements, but had also to give representations of the soft parts. It seemed to me, further, especially desirable to display the internal architecture

of the different species in a clear way, so that it might be possible, at a glance, to survey and compare the different forms. With this view I have not only given figures of the entire Sponges, of special fragments, and of the skeletal elements, but also numerous *ideal* (less highly magnified) sections through the body-wall. In these diagrammatic figures, which are composed from a number of microscopic sections, the skeletal elements are indicated in blue. If I had attempted to copy the individual sections exactly as they appeared, the essential and typical could not, as a rule, have been distinguished from the unessential and accidental, except, of course, by giving a larger number of illustrations than seemed justifiable for such a slight possible advantage.

Since I had repeated occasion to restudy the rich material, even after the plates were printed off (*i.e.*, at a time when it was no longer possible to introduce corrections), I have been forced several times to indicate a change in my original opinion, by a correction in the text, or by a change in the specific designation of the plates.

GENERAL HISTORICAL INTRODUCTION.

All siliceous Sponges in which the spicules belong to the triaxial type were, in 1870, designated by Oscar Schmidt "Hexactinellidæ." This title, which I would only modify into Hexactinellida, since the termination *idæ* should be exclusively reserved for the designations of families, soon found general acceptance, although Wyville Thomson had previously established under the name of Vitrea an order of siliceous Sponges in which the characteristic peculiarity was defined by the reference of all the spicules to the hexradiate type. The older title proposed by Wyville Thomson has not gained currency, since among the representatives of Vitrea enumerated by him forms occur in which the skeletal elements are *not* referable to the hexradiate type, and which accordingly belong to another order.

Confining myself at this stage to a short review of the historical development of our knowledge of the Hexactinellida in general, I purpose subsequently to preface the description of each genus with an accurate account of the relevant literature.

First of all, there are a few isolated contributions of comparatively ancient date, which give some account of certain structures which differed essentially in their peculiar form and siliceous framework from any marine forms then known, but which, when subjected to careful criticism, can be referred to certain now fairly familiar Hexactinellida. Thus Rozier's Journal de Physique for 1780, and a transcript from that work in the Magazin für das Neueste aus der Physik und Naturgeschichte (published by Lichtenberg, Bd. 1, Gotha), 1781, contain a description and a very characteristic representation of a form belonging to the genus *Dactylocalyx*. This contribution, for an acquaintance with which I am indebted to Dr. W. Marshall of Leipzig, is probably the earliest notice of a Hexactinellid. In the Synopsis of the Contents of the British Museum for 1832, Gray described a peculiar "glass rope like" structure preserved in the British Museum. This he named *Hyalonema*, and described it carefully, though without recognising its real nature as the basal tuft of a Hexactinellid.

In the Voyage de "l'Astrolabe," 1833, Quoy and Gaimard figured and described, under the name *Alcyoncellum speciosum*, a sponge form which undoubtedly belonged to the Hexactinellida.

Similar individual descriptions became gradually more numerous, and up to 1860 the following may be noted as most important:—*Dactylocalyx pumiceus*, Stuchbury,[1] 1841, *Euplectella aspergillum*, Owen,[2] 1841, *Farrea* sp., Owen,[3] 1857, *Aphrocallistes beatrix*, Gray,[4] 1858, and *Myliusia callocyathus*, Gray,[5] 1859.

A more profound study of the skeletal structure of *Hyalonema sieboldii* was made in 1860 by Max Schultze.[6] He also discovered, in those spicules which did not externally exhibit a cruciate or stellate, but merely a simple rod-like form, an intersection of the axial canals in a median swelling, which indicated the fundamental stellate type of all the spicules. He was also the first to discover the close affinity of *Hyalonema* and *Euplectella*, which, on account of the common character of the spicular tuft, he united in the group "Lophospongiæ."

Bowerbank[7] (1862) was less fortunate in his perception of the affinities of the Hexactinellid genera known to him, viz., *Alcyoncellum* (*Euplectella*, Owen), Quoy and Gaimard, *Hyalonema*, Gray, *Dactylocalyx*, Stuchbury, and *Farrea*, Bowerbank. For while he placed the genus *Alcyoncellum*, Quoy and Gaimard (with *Euplectella*, Owen, in parenthesis), in his suborder Silicea with *spiculo-radiate skeletons*, between *Ecionema*, Bowerbank, and *Polymastia*, Bowerbank, he referred the genus *Hyalonema*, Gray, to another quite different suborder, characterised by *spiculo-reticulate skeletons*, between *Halichondria*, Flemming, and *Isodictya*, Bowerbank. Of each of the two genera, *Dactylocalyx*, Stuchbury (=*Iphiteon*, Mus. Paris), and *Farrea*, Bowerbank, he made, on the other hand, a special suborder, of which the former was characterised chiefly by *solid siliceo-fibrous*, and the second (*Farrea*) by *canaliculated siliceo-fibrous skeletons.*

In Gray's System of Sponges,[8] which appeared in 1867, the Hexactinellida then known were not yet united into a common group. For while Gray placed the family of the Euplectellidæ, consisting of *Alcyoncellum* and the closely allied *Euplectella*, with his Esperiadæ and Tethydæ, in the order of the Acanthospongiæ (with *spicules of more than one form or kind in the same Sponge*) and within the subsection Spiculospongiæ (with free spicules), on the other hand he united the family of the Aphrocallistidæ, consisting of the genus *Aphrocallistes*, with the family of the Dactylocalycidæ, including *Dactylocalyx*, Stuchbury, *Myliusia*, Gray, *MacAndrewia*, Gray, and *Farrea*, Bowerbank, in a special order, "Corallispongiæ," within the subsection "Dictyospongiæ" (in which the skeleton is formed of a continuous siliceous or horny network). The Corallispongiæ were characterised by Gray as:—"Hard, coral-like Sponges, entirely formed of siliceous spicules, anchylosed together by siliceous matter into a network. Mass covered with a thin coat of sarcode when alive."

[1] *Proc. Zool. Soc. Lond.*, vol. ix. pp. 86, 87.
[2] *Proc. Zool. Soc. Lond.*, vol. ix. pp. 3–5.
[3] *Trans. Linn. Soc. Lond.*, vol. xxii. pp. 117–124.
[4] *Proc. Zool. Soc. Lond.*, vol. xxvi. pp. 114, 115.
[5] *Proc. Zool. Soc. Lond.*, vol. xxvii. pp. 437–440.
[6] Die Hyalonemen, 1860, 4.
[7] *Phil. Trans.*, vol. clii. 2 pp. 747, 830, 1087.
[8] *Proc. Zool. Soc. Lond.*, 1867, pp. 117, 492, 1001.

Claus[1] now pronounced against any close systematic union of *Euplectella* and *Hyalonema*.

On the other hand, in 1868 Wyville Thomson first recognised the common relationship of all Hexactinellida, though he was not able to separate them sufficiently sharply from the Lithistida. The characters of his order Vitrea were given in these words:[2]—"Sarcode in small quantity, very soft, never containing formed horny matter, either fibrous, membranous or granular. The skeleton consists entirely of siliceous spicules, either separate (in fascicles or scattered) or anastomosing and combined into a continuous siliceous network. The sarcode contains small spicules of a different character from the general spicules of the skeleton, and of complicated forms. The spicules, whether of the skeleton or of the sarcode, may all be referred to the hexradiate stellate type," and in another place (Phil. Trans., 1869, p. 713):—"In all the known genera all the spicules are modifications of the hexradiate stellate type."

In the order Vitrea, Wyville Thomson noted (*loc. cit.*, p. 713) the following genera and species:—

Genus 1. *Euplectella*, Owen, .	*Euplectella aspergillum*, Owen.
„ 2. *Habrodictyon*, Wyv. Th., .	*Habrodictyon speciosum*, Quoy et Gaimard.
	Habrodictyon corbicula, Valencienne.
„ 3. *Aphrocallistes*, Gray, .	*Aphrocallistes beatrix*, Gray.
	Aphrocallistes bocagei, Wright.
„ 4. *Dactylocalyx*, Stuchbury, .	*Dactylocalyx pumicea*, Stuchbury.
	Dactylocalyx subglobosa, Gray.
	Dactylocalyx prattii, Bowerbank.
	Dactylocalyx callocyathes, Gray.
	Dactylocalyx azorica, Gray.
	Dactylocalyx (?) *torva*, Duchassaing et Michelotti.
„ 5. *Farrea*, Bowerbank, .	*Farrea occa*, Bowerbank.
„ 6. *Holtenia*, Wyv. Thom., .	*Holtenia carpenteri*, Wyville Thomson.
„ 7. *Hyalonema*, Gray (in part),	*Hyalonema sieboldii*, Gray.
	Hyalonema lusitanicum, Gray.
	Hyalonema loveni, n. sp.
„ 8. *Adrasta* (n. gen.), .	*Adrasta infundibulum*, n. sp.

If we except the genus *Adrasta*, which, though named, has remained undescribed, and even undiagnosed, and further, the above-mentioned *Hyalonema loveni*, which is not sufficiently defined, and finally the doubtful *Dactylocalyx torva*, Duch. and Mich., there are only two of the above-cited species quoted which are not Hexactinellida, but belong to the Lithistida, namely, *Dactylocalyx prattii*, Bowerbank, and *Dactylocalyx*

[1] Uber Euplectella aspergillum, 1868, p. 4.

[2] *Ann. and. Mag. Nat. Hist.*, 1868, vol. i. pp. 114–132.

azorica, Gray. The young forms described by Wyville Thomson in his memoir on *Holtenia*, are in several points suggestive of *Hyalonema*.

Among the numerous *siliceo-fibrous sponges*, which Bowerbank[1] described at the same time in the Proceedings of the Zoological Society, there are also many forms, such as *Caliapsis cidaris*, Bowerbank, *Dactylocalyx heteroformis*, Bowerbank, *Dactylocalyx macandrewii*, Bowerbank, *Dactylocalyx prattii*, Bowerbank, *Dactylocalyx masoni*, Bowerbank, *Dactylocalyx bowerbankii*, Johnson, *Dactylocalyx polydiscus*, Bowerbank, which belong not to the Hexactinellida, but to the Lithistida. With regard to Bowerbank's remarks on the structure of the Hexactinellida, his description of a special skin or cortical layer with peculiar skeletal elements deserves to be noted.

In addition to further descriptions of some new Hexactinellid species,—such as *Eurete simplicissima*, Semper, *Euplectella oweni*, Herklots and Marshall, *Pheronema annæ*, Leidy, *Semperella schultzii*, Semper, &c.,—protracted discussions on the systematic position of *Hyalonema* and *Euplectella*, and on their mode of attachment, were continued for several years.

Some new genera and species from the Atlantic area were described in 1870 by Oscar Schmidt,[2] who, after very accurate study of the axial relations of the siliceous spicules, was the first, as above noted, sharply to distinguish the Hexactinellida from all other Sponges, and especially from the Lithistida, with which they had been hitherto more or less united.

While the genera *Lanuginella* and *Sympagella*, which were then established by O. Schmidt, are without doubt true Hexactinellida, I cannot say the same of *Placodictyum cucumaria*, O. Schmidt. Preparations of the skeleton which exhibit broken plates and bent knotted rods, were kindly given to me for examination by Prof. O. Schmidt himself, and from these I have been able to convince myself that by the action of acids the elements are dissolved with the liberation of gas, so that they are evidently not of silica, but lime carbonate. It seems probable, in fact, that we have to deal with a Holothurian—*Thyone*—and this supposition is confirmed by the general form of the organism as figured.

By means of microscopic examination—which had been but little applied to the study of fossil Sponges—certain forms belonging to the genera *Scyphia* and *Ventriculites* were indubitably referred by O. Schmidt to the Hexactinellida.

About the same time Saville Kent,[3] who had found on the coasts of Spain and Portugal several little known Hexactinellida, including the new genera *Asconema*, Kent, and *Fieldingia*, Kent, gave a systematic review of all the then known Hexactinellid genera, and distributed them in two suborders, as follows:—

I. CORALLIOSPONGIÆ, Gray. Sponge body supported by an anastomosing or continuous reticulate skeleton. Reproductive gemmules entirely membranous, aspiculous.

[1] *Proc. Zool. Soc. Lond.*, 1868, pp. 118–137; 1869, pp. 66, 323, 389.
[2] O. Schmidt, Grundzüge einer Spongienfauna des atlant. Gebietes, 1870.
[3] *Monthly Micr. Journ.*, 1870, p. 241.

Genera :—*Euplectella*, Owen, *Habrodictyon*, Wyville Thomson, *Aphrocallistes*, Gray, *Farrea*, Bowerbank, *Aulodictyon*, Kent, *MacAndrewia*, Gray, *Dactylocalyx*, Stuchbury, *Fieldingia*, Kent.

II. Callicispongiæ, S. Kent. Sponge body supported by an interlacing or isolated spicular skeleton; never by a reticulate and continuous one. Reproductive gemmules membranous, furnished with protective spicules.

Genera :—*Pheronema*, Leidy, *Hyalonema*, Gray, *Asconema*, Kent, *Sympagella*, O. Schmidt, *Lanuginella*, O. Schmidt, *Vazella*, Gray.

In his Grundzüge der Zoologie, Claus maintained the union of the spicules into a firm network to be an important character of all Hexactinellida (which constitute his suborder of Hyalospongiæ), while Carter, 1873, like Saville Kent, only emphasised the differences in the modes of union of the spicules as the main basis of his classification. Carter [1] established the three following families :—

I. Vitreohexactinellida.

Spicules held together by silicified fibre.

Dactylocalyx, *Myliusia*, *Euplectella aspergillum*, *Aphrocallistes*, *Aulodictyon*, *Farrea*, *Sympagella*.

Including the three groups:
1. Patulina. Example—*Dactylocalyx pumiceus*, Gray.
2. Tubulina. Example—*Euplectella aspergillum*, Owen.
3. Scopulifera. Example—*Aphrocallistes bocagei*, Wright.

II. Sarcohexactinellida.

Spicules held together by amorphous sarcode.

Asconema, *Crateromorpha*, *Rossella*, *Habrodictyon*, *Hyalonema*, *Pheronema*, *Meyerina*.

Including the two groups:
1. Rosettifera. Example—*Rossella*, Carter, and *Crateromorpha meyeri*, Gray.
2. Birotulifera. Example—*Hyalonema sieboldi*, Gray; *Holtenia*, Wyv. Thomson; *Meyerina*, Gray, and *Labaria*, Gray.

III. Sarco-vitreohexactinellida.

Spicules held together in one part by vitrified fibre, in the other by amorphous sarcode.

Euplectella cucumer, Owen.

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 349; vol. xvi. p. 199.

These siliceous spicules which are united into a continuous network, or which form, in virtue of their large size and mutual apposition, a supporting framework for the entire sponge body, were termed by Carter "skeleton spicules,"—in opposition to the far smaller "flesh spicules" which are loosely embedded in the soft tissue. In the new genera *Rossella*, Carter, and *Crateromorpha*, Gray, Carter was able to distinguish several species.

In 1875 Marshall published his researches on the skeleton of several sponge forms, some imperfectly known, and others newly discovered, *e.g.*, the genera *Sclerothamnus*, Marshall, and *Periphragella*, Marshall. The affinities of the Hexactinellida were discussed by Marshall in a special work. To start with, he distinguished Synauloidæ and Asynauloidæ. In the former the entire lattice network is said to be penetrated by a continuous system of axial canals, while in the latter the canals of the spicules which fuse to form the network do not communicate. To the Synauloidæ Marshall referred only the genus *Sclerothamnus*. The Asynauloidæ he divided into (1) Monacidæ, with only one form of spicule; (2) Pleionacidæ with forks and rosettes, in addition to the six-rayed forms; and (3) Pollacidæ, with numerous distinct forms of spicules, a special dermal skeleton, and an inner covering for the gastral cavities. While Marshall placed in the division Monacidæ only the genus *Eurete*, he assigned to the Pleionacidæ the genera *Lanuginella*, Schmidt, *Asconema*, Kent, *Farrea*, Bowerbank, *Periphragella*, Marshall, *Aulodictyon*, Kent, *Fieldingia*, Kent, and *Aphrocallistes*, Gray; to the Pollacidæ, on the other hand, he ascribed the family of the Holteniadæ with *Holtenia*, Wyv. Thomson, *Crateromorpha*, Gray, *Rossella*, Carter, *Sympagella*, Schmidt, *Placodictyum*, Schmidt, the family of the Euplectellidæ with *Euplectella*, Owen, and *Habrodictyum*, W. Thomson, and the family of the Hyalonematidæ, with *Labaria*, Gray, *Pheronema*, Leidy, *Semperella*, Gray, and *Hyalonema*, Gray.

In 1877, Sollas[1] described with great thoroughness a new fossil Hexactinellid genus with two species. Both in the dermal layer, or "oscular plate" as he termed it, and in the thick body mass, Sollas noted a framework of siliceous strands intersecting at right angles. The usual axial canals were present, but the nodes were not penetrated by them, *i.e.*, they did not exhibit any octahedral or lantern-like form. To indicate the systematic position of this new genus, Sollas elaborated the following classification of the Vitreohexactinellids, according to the characters of the skeletal network :—

I. Sexradiate skeleton spicules, always rectangular. Stauronemata.
- (*a*) Skeletal network, with simple nodes.
  - 1. One layer in thickness, . . . *Farrea.*
  - 2. Several layers thick, . . . *Stauronema.*
- (*b*) Skeletal network having the nodes complicated by the presence of an octahedral lantern about each node, ... Ventriculitidæ, including *Myliusia grayi.*

[1] *Ann. and Mag. Nat. Hist.*, ser. 2, vol. xix. p. 1.

II. Sexradiate skeleton spicules, with rays making any angle with each other. Aphrocallistidæ, . . .	*Aphrocallistes, Dactylocalyx, Iphiteon, Stromatopora* (*Callodictyon*, Sollas, n. gen.) *concentrica*.
III. Skeleton spicules, cemented into ladder-like fibre. Euplectellidæ, ...	*Euplectella, Sympagella*.

Zittel's epoch-making work on fossil Sponges[1] contains very accurate descriptions, not only of the form of the body and nature of the surfaces, but of the system of canals that penetrate the body, and especially of the fine microscopic structure of the siliceous framework. The flesh spicules which lay loosely in the soft tissues, and were thus, for the most part lost, could not of course be so closely studied.

As the main basis of his classification Zittel emphasised the differences in the modes of union exhibited by the skeletal spicules, a basis of division which had been already employed by Saville Kent and Carter. He distinguished those forms "in which the skeletal spicules usually remain isolated and are only united by sarcode," from those "in which the skeletal spicules are fused in a regular manner and form a continuous lattice-work with cubical or polyhedral meshes." The former he named Lyssacina, the latter Dictyonina.

That intercommunication of the lumina of the axial canals throughout all the spicules fused into the lattice-like framework, which had been observed by Marshall in *Sclerothamnus*, was not corroborated by Zittel, either in any fossil Hexactinellid or even in *Sclerothamnus* itself. It seemed to him, further, that the formation of a special group of Monacidæ, in Marshall's sense, was unwarranted, at least as regards the division of the Dictyoninæ, but he himself formed, within the Lyssacina, from certain fossil genera, a similar group, and ranged alongside of it the Pleionacidæ and and Pollacidæ.

I will here cite the fundamental principles of Zittel's Hexactinellid system of 1878 :—

Class Spongia.

Order HEXACTINELLIDA, O. Schmidt.

Siliceous Sponges with six-rayed spicules, isolated or fused into a lattice-work of a hexradiate pattern. All the siliceous elements exhibit the same fundamental structure, with an axial cross formed by three central canals intersecting at right angles. In addition to the peculiar skeletal needles there are numerous isolated flesh spicules, mostly very delicate in form.

[1] *Abhandl. d. II. Cl. k. baier. Akad. d. Wiss.*, xiii., 1878.

Suborder I. DICTYONINA, Zittel.

Skeletal spicules fused in such a way that every arm of a six-rayed spicule is applied to the corresponding arm of a neighbouring spicule, so that both become surrounded by a common siliceous covering. The continuous skeleton consists of a framework, with cubical or irregular meshes. Flesh spicules present or absent.

Family 1. ASTYLOSPONGIDÆ, Zittel.

Sponge body very thick walled, unstalked, free (occasionally fixed by a broadly expanded base). Water vascular system consisting of radial canals extending from the surface to the centre, besides which vertical tubes disposed in radial rows to the number of eight or ten, are generally present. Lattice framework tolerably irregular with thick nodes of intersection.

Only fossil forms from the Silurian.

Family 2. EURETIDÆ.

Fixed sponge bodies beaker-like, cylindrical, top-like or branched. Skeleton lattice-like; the intersection nodes of the fused hexradiate spicules non-perforated. Surface naked or protected by a thickening of the outer skeletal layer, sometimes covered with a very delicate network of fused spicules, which, in their form, differ but slightly from those of the rest of the skeleton. This outer dermal meshwork also surrounds the ostia. Structure of the root resembling that of the rest of the sponge body. Flesh spicules absent or present.

(*a*) Canal system well developed. Ostia of the blind radial canals occur variably on either surface. In addition to fossil genera belonging to different strata, this subfamily is represented by the living genus *Sclerothamnus*, Marshall.

(*b*) Canal system absent or scarcely developed. Besides the fossil genus *Verrucocœlia*, the living genera *Farrea*, Bowerbank, *Eurete*, Marshall, and *Aulodictyon*, S. Kent.

Family 3. COSCINOPORIDÆ, Zittel.

Sponge body beaker-like, stellate or branched, more frequently compressed. Radial canals very numerous, simple, straight, and blind. Ostia small. Skeleton finely meshed, dense, stony. The numerous radial canals exhibit the regular formation of cubical meshes. The intersection nodes of the six-rayed spicules are thick and seldom perforated. Dermal layer usually absent or only formed by a thickening of the outermost skeletal layer.

Examples.—*Coscinospora* and other fossil genera.

Family 4. MELLITIONIDÆ, Zittel.

Sponge body branched, spherical or flat. Body-wall completely perforated by numerous tubular water canals, and thus divided into honeycomb-like cells. Skeletal spicules with thick nodes of intersection. Surface (naked or) covered by a delicate, meshed or porous, siliceous skin, which also covers the openings of the canals. Root tuft absent.

Examples.—The genus *Aphrocallistes*, Gray, which is known both in the living and fossil form, the living genus (?) *Fieldingia*, Saville Kent, and the fossil genus *Stauronema*, Sollas.

Family 5. VENTRICULITIDÆ, Zittel.

Sponge body simple or polyzoic, beaker-, funnel-, or top-like, cylindrical or branched. Wall irregularly folded. Lattice framework with octahedral perforated nodes of intersection. Canal system usually well developed. Radial canals blind. Both surfaces with ostia or longitudinal furrows. Dermal layer seldom absent, and usually formed by thickening of the outer skeletal layer. Roots consisting of prolonged siliceous fibres united by transverse bridges and without axial canals.

Examples.—*Ventriculites* and other fossil genera.

Family 6. STAURODERMIDÆ, Zittel.

Sponge body top- or funnel-like, seldom branched. Lattice skeleton more or less regular. Intersection nodes thick or octahedral, perforated. The outer, or both surfaces of the wall provided with stellate spicules, which differ in form from those of the rest of the skeleton, and are either but loosely cemented to one another, or lie embedded in a continuous siliceous skin.

Examples.—*Stauroderma* and other fossil genera.

Family 7. MÆANDROSPONGIDÆ, Zittel.

Sponge body consisting of intricately labyrinthine and anastomosing thin-walled tubes or foliæ. Canal system absent or scarcely developed. Intercanalicular system always present. Dermal layer absent or represented by a continuous siliceous superficial skin.

Examples.—Besides *Cystispongia* and other fossil genera, the living genera *Dactylocalyx*, Stuchbury, *Periphragella*, Marshall, and *Myliusia*, Gray (*pro parte*).

Family 8. CALLODICTYONIDÆ, Zittel.

Sponge body beaker-like. Wall consisting of a regular wide-meshed lattice-like framework with octahedral intersection nodes; canal system absent or confined to the sometimes very thick dermal layer of the lattice-like skeleton.

Examples.—*Callodictyon*, Zittel, and other fossil genera.

Family 9. CŒLOPTYCHIDÆ, Zittel.

Sponge body umbel-like, stalked. Wall thin, deeply folded; the central cavity divided into radial chambers. Upper surface shallow or deepened, entirely enveloped by a continuous dermal layer which usually consists of variable coarse and finely porous strands. Canalicular ostia only on the under side of the umbel, on the backs of the folds, sometimes also on the stalk. Lattice framework with large, regular, cubical meshes. The intersection nodes of the amalgamated six-rayed spicules octahedral, perforated. The radii of the six-rayed spicules bear thorny and root-like protuberances.

Example.—The single fossil genus *Cœloptychium*.

Suborder II. LYSSACINA.

The whole skeleton consisting of spicules which are bound together only by sarcode (exceptionally also by a smooth siliceous substance in irregular ways). Flesh spicules usually present in rich abundance and much differentiated.

Family 1. MONACIDÆ, Marshall.

Whole sponge body composed of similar spicules.

Examples.—*Acanthospongia*, Salt, and *Stauractinella*, Zittel.

Family 2. PLEIONACIDÆ, Marshall.

Main portion of the skeleton composed of six-rayed spicules and also of forks and rosettes.

Examples.—The living genera *Asconema*, Kent, and *Lanuginella*, Schmidt.

Family 3. POLLACIDÆ, Marshall.

Form of skeleton and flesh spicules very variable. Special dermal skeleton and inner lining of the gastral cavities present. Base usually forming a root-tuft of long siliceous spicules.

Examples.—The living genera *Holtenia*, Schmidt, *Pheronema*, Leidy, *Crateromorpha*, Gray, *Rossella*, Carter, *Sympagella*, Schmidt, *Placodictyon*, Schmidt, *Euplectella*, Owen, *Habrodictyum*, Wyv. Thomson, *Labaria*, Gray, *Semperella*, Marshall (*Meyerina*, Gray), *Hyalonema* (*Carteria*), Gray, and ? *Acestra*, Roem, from the Silurian.

In the report which Marshall and Meyer[1] made in 1877 on the Philippine Hexac-

[1] *Mittheilungen aus d. Königl. Zool. Museum in Dresden*, 1877, p. 263.

tinellida, they described, in addition to some new species of the genera *Myliusia* and *Aulodictyon*, a new genus *Hyalocaulus*, and gave an explanation of the hollow octahedral nodes which occur so abundantly in fossil Hexactinellida, but less frequently in living forms.

To the communications which Wyville Thomson[1] made in 1877 on some specially noteworthy Hexactinellida from the Challenger material,—such as *Euplectella suberea*, *Hyalonema toxeres*, *Poliopogon amadou*, *Lefroyella decora*, and others,—I will refer at greater length when noting the literature of the genera and species in question.

An important addition to our knowledge of the Hexactinellida was made in 1880 by O. Schmidt.[2] He gave a description of the forms collected by Agassiz in the Gulf of Mexico, and entered into a discussion of their affinities and other general questions, without, however, undertaking an independent elaboration of the system.

Schmidt does not deny the merit of Zittel's systematic grouping of all known fossil and living species into genera, families, and orders, but while admitting its utility for the practical purposes of the geologist, expresses his doubt whether Zittel's system represents even approximately the natural affinities. He does not therefore feel himself warranted in arranging the genera described in any completely articulated system.

In the living Dictyonina, Schmidt sees only "representatives of the incompletely or altogether unknown fossil Sponges, whose affinities will for ever remain concealed"; the Lyssacina, on the other hand, are "for the most part so closely related to one another, that the boundaries between the genera may be moved quite arbitrarily." The Euplectellidæ and Hyalonematidæ appear to him genuinely natural families, but he does not give the same credit to Marshall's Holteniadæ.

It is a great pity that some of the genera established by O. Schmidt have been described from fragments but slightly characteristic, and sometimes so shortly that it is difficult to obtain any sufficient conception of their characters. This is especially the case with the new genera *Diaretula*, *Cyathella*, *Diplacodium*, *Pachaulidium*, *Rhabdostauridium*, and *Leiobolidium*.

The three genera *Farrea*, Bowerbank, *Eurete*, Marshall, and *Aulodictyon*, Kent, are united by Schmidt into a new genus *Farrea*, of which he found but one species, *Farrea facunda*, represented by numerous and certainly very variable examples. A new genus, *Syringidium*, Schmidt is inclined to refer to the *Lefroyella decora*, Wyville Thomson, figured and briefly described in Wyville Thomson's Atlantic.

Of the genus *Cystispongia*, hitherto only known in the fossil condition, he describes a living representative as *Cystispongia superstes*. The genus *Margaritella*, Schmidt, is supposed to be closely allied to *Cœloptychium*, but it does not possess the perforated

[1] The Atlantic, 1877.

[2] Die Spongien des Meerbusens von Mexico, ii. p. 33.

octahedral nodes. *Joannella*, Schmidt, is distinguished by its narrow meshed network and the marked fissures associated with this character. In one species of the new genus *Scleroplegma* (*Scleroplegma laterna*) there are perforated octahedral nodes, while in the other species of the same genus the nodes are solid. In *Volvulina sigsbei*, O. Schmidt, which is distinguished by the knotted cords of the siliceous network of beams, Schmidt thinks that he can prove the non-fixity of certain characters of the Dictyonine lattice-like tissue, characters which have been principally used by Zittel in the classification and determination of fossil Hexactinellida. While, namely, in some parts of the lattice network smooth rays and rough knots appear, in other regions of the same specimen the rays are also rough. Many specimens of the same species exhibit rough rays and smooth knots, the exact reverse of what has just been stated above. Schmidt has also found that the form of the meshes is very variable and uncertain, they are sometimes cubical, sometimes predominantly polyhedral, sometimes quite irregular.

Of Euplectellidæ Schmidt mentions, besides *Euplectella jovis*, which is a species nearly related to *Euplectella suberea*, Wyv. Thomson, a new genus *Regadrella*, including the single species *Regadrella phœnix*, which is devoid of the siliceous tuft and is fixed to the rocky substratum by a firm base. Though in this form a very constant character of the Lyssacina is evidently absent, it must be noted that other forms occur which are quite firm and compact beneath, lattice-like in the middle, and loosely constituted above, such as, for example, *Hertwigia falciformis*, Schmidt, and *Rhabdopectella tintinnus*, Schmidt, and these were direct transitional forms between Dictyonina and Lyssacina.

Of the genus *Hyalonema* Schmidt has described only fragmentary pieces. The form described by him as *Asconema kentii* is certainly a species of *Hyalonema*.

The then little known structure of the soft body of the Hexactinellida was, in 1880, elucidated by my[1] investigation of some well-preserved specimens of *Euplectella aspergillum*, which were given to me by Sir Wyville Thomson from the treasures of the Challenger expedition.

In a subsequent study of the Hexactinellid material from the Gulf of Mexico, which had been already utilised by O. Schmidt, but which was re-examined by Weltner[2] in 1882, the structure of the peculiar skin and covering layers was especially considered. This had, it is true, been previously described by Zittel in several fossil forms, but in living forms it had hitherto been insufficiently known, and had been investigated, in fact, only in a few cases, such as in *Aphrocallistes* by Zittel, in *Myliusia* by Marshall, and in *Dactylocalyx pumiceus* by Sollas. Weltner was able to demonstrate the presence of these structures in numerous modern Dictyonina, *e.g.*, in *Farrea*, *Syringidium*, *Aphrocallistes*, *Volvulina*, *Joannella*, *Margaritella*, *Scleroplegma*, and *Cystispongia*. Like Zittel he distinguished "covering layers, dependent and independent of the lattice-

[1] *Trans. Roy. Soc. Edin.*, vol. xxix., 2, p. 661.

[2] Weltner, Beiträge zur Kenntniss des Spongien, 1882.

skeleton." The former are flat thickenings of the lattice-skeleton on those regions where the sponge was in contact with, or lay against some solid body; while the "independent covering layers" surround the external and also the gastral surface, in the form of a skin-like web of fine free or united spicules.

The remarkable rigid balls, first observed by Saville Kent in his *Fieldingia lagettoides*, and later by O. Schmidt in *Cystispongia superstes*, which seemed to be formed of condensed portions of the lattice-like network, were observed by Weltner in several other Dictyonina, such as *Scleroplegma lanterna*, *Myliusia zittelii*, and *Margaritella cœloptychioides*.

From the preliminary reports on the Hexactinellida collected off the coasts of France and West Africa by the French deep-sea expedition of the "Travailleur" and "Talisman," it appears that not only were most of the species collected by the Challenger discovered in the localities in question, but some new species were added.

In a popular account of the expeditions of the "Travailleur" and "Talisman," La vie au fond des mers, 1885, Filhol notes some of the Hexactinellid forms, *e.g.*, "Euplectella suberea, Wyv. Thomson, qui est largement repandue dans l'Atlantique nord. Pendant la croisière du Talisman nous les avons draguées à diverses reprises par des fonds variant entre 900 et 2300 mètres. En certains points elles étaient d'une extrème abondance et devaient couvrir d'assez vastes espaces."

A new form is reported (*loc. cit.*, p. 284), and figured on pl. viii., viz., "Trichaptella elegans, H. Filhol, fixé sur des Coraux (Lophohelia) sur les côtes du Maroc par 865 mètres de profondeur. Sa base est formée de spicules siliceux agglutinées les uns avec les autres et formant ainsi un réseau d'une grande solidité. Le restant du corps de l'éponge, qui s'élargit dans sa partie moyenne, est souple comme chez les Euplectelles. L'oscule, fermé par un treillage à mailles grandes et irrégulières est entouré par une collerette de longs spicules d'une extreme délicatesse."

"Les Pheronema paraissent être répandus dans tout l'Atlantique, dont elles habitent en certains points de très grandes profondeurs. Communes sur la côte du Portugal, elles apparaissent encore plus nombreuses au large des côtes du Maroc et du Senegal, en profondeur de 600 mètres jusquà 2200 mètres."

"Certaines d'entre elles sont remarquables par un enorme développement, alors que d'autres, telles que Pheronema Parfaiti se font remarquer par leur transparence et l'absence de collerette de spicules autour de l'oscule."

"L'Asconema setubalense n'avait été trouvé, jusqu'au voyage du Talisman, que sur les côtes du Portugal. Lors de la campagne de ce dernier bateau, nous l'avons recueilli sur les côtes du Maroc, au voisinage du Cap Bojador, par 410 mètres."

"Les Aphrocallistes sont communes sur les côtes du Portugal, du Maroc, du Sénégal et s'étendant aux parages des îles du Cap Vert, des Canaries, des Azores. Les Aphrocallistes Bocagei constituent, au fond de certaines portions de l'Atlantique nord, des

colonies quelquefois assez distantes les unes des autres. Nous les avons observées à des profondeurs bien définies et cela à partir de 860 mètres jusquà 2200 mètres."

"Les Asconema ont été trouvées avec les Aphrocallistes; les Hyalonema et les Euplectella étaient presque tousjours associées."

A Catalogue of the Fossil Sponges in the Geological Department of the British Museum, which appeared in 1883, contains a thorough account, by G. J. Hinde, of the fossil Sponges in the above museum. The Hexactinellida are thoroughly discussed, and the whole work closely adheres to Zittel's system. In my general survey I may subsequently refer to the fossil Hexactinellids, and shall then rely on Zittel's pioneer work and on Hinde's excellent memoir.

In 1884[1] Zittel demonstrated that the family of Astylospongidæ (with the genera *Astylospongia*, F. Rœmer, *Palæomanon*, F. Rœmer, *Protachilleum*, Zittel, and *Eospongia*, Billings) belonged not to the Hexactinellida, as had been hitherto supposed, but to the Lithistida, and, in fact, to the group Anomocladina.

In a collection of marine Sponges gathered in Japan by Dr. T. Anderson, Mr. H. T. Carter[2] notes the occurrence of four Japanese Hexactinellids, namely, *Hyalonema sieboldii*, Gray, *Farrea occa*, Bowerbank, *Periphragella elisæ*, Marshall, and *Hexactinella ventilabrum*, new species, Carter. Of these accurate descriptions are given, based partly on dried specimens. Especially important in this report, as it appears to me, is a clear and comprehensive description of the skeletal parts of *Farrea occa*, Bowerbank, accompanied with excellent figures. A definite and reliable conception of this, hitherto somewhat indistinct, species has thus been established.

[1] *Jahrb. f. Min.*, Bd. ii. p. 75, 1884. [2] *Ann. and Mag. Nat. Hist.*, 1885, ser. 5, vol. xv. p. 387.

GENERAL REMARKS ON THE FORM AND STRUCTURE OF THE HEXACTINELLIDA.

Although the different species of the Hexactinellida vary greatly in form and structure, they nevertheless exhibit so essential an agreement in the fundamental features of their organisation, that it is easy to reduce all known forms to a common type. Apart altogether, for the present, from the skeletal portions, this common type resembles a simple sac, in which the outer surface is formed of a thin skin rich in pores (the *dermal membrane*), through which water enters into a space (the *subdermal trabecular space*) crossed by fine trabeculæ. Within this there is a single layer of closely arranged chambers shaped like the finger of a glove, with wide internal openings, and with fine walls (the *membrana reticularis*), supported by an elegant quadrate network, and penetrated by small round pores (*chamber pores*) for the passage of water. A connecting membrane extends between the internal openings of the chambers, and is in direct continuation with the walls of the chambers. This membrane generally agrees in structure with that bounding the chambers, and closes internally the clefts and apertures which occur between the latter. Through the pores of the chamber walls and the connecting membrane, the water reaches an *inner* or *subgastral trabecular space*, which is likewise crossed by fine trabeculæ, and is separated from the wide gastral cavity by a porous or net-like internal limiting skin, or gastral membrane.

From the exterior inwards the following successive layers occur :—(1) the outer limiting skin or *dermal membrane ;* (2) the outer or *subdermal trabecular framework ;* (3) the *chambers* with their connecting membrane ; (4) the inner or *subgastral framework ;* (5) the inner uniting or *gastral membrane.*

The body of every Hexactinellid is invariably made up of these five layers in the same order, but the designation of the layers as outer and inner refers not so much to their relation to the centre of the individual sponge, as to the direction of the stream of water. Thus the *dermal membrane* always refers to that through which the water enters the sponge body, and the *gastral membrane*, on the other hand, to that through which it escapes from the body-wall into the gastral space, or directly to the exterior.

In the attempt to trace the manifold modifications of the numerous species of

Hexactinellida from the fundamental type, I will begin with those forms which, like *Bathydorus fimbriatus*, are only slightly removed from the original saccular form, and which by a simple elongation have assumed a tube-like outline. In a section through the lamelliform smooth wall of *Bathydorus fimbriatus*, such as is somewhat diagrammatically represented in Pl. LVIII. fig. 2, the only essential modification of the fundamental type is a peculiar folding of the chamber layer. This layer exhibits a series of closely disposed broad protrusions of approximately similar form and equal size, which

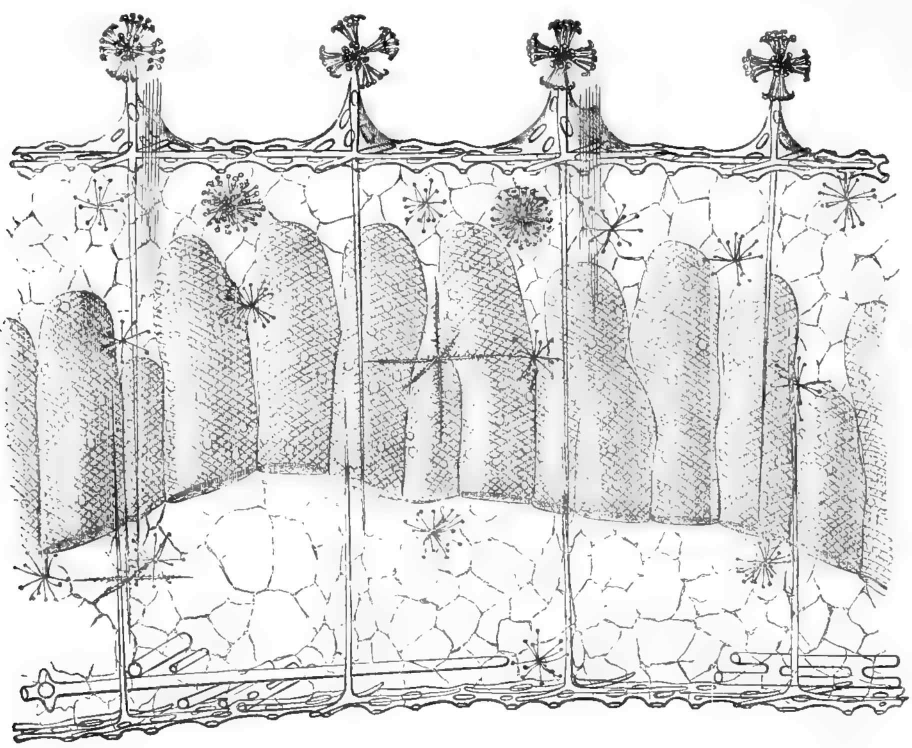

FIG. 1. Section of the wall of *Walteria flemmingii*, n. gen. et sp.

raise the smooth external skin in such a way that diverticula, traversed and divided by trabeculæ, extend inwards from the subdermal lacunæ of the outer trabecular space. The lumina of the protrusions which open by a wide round aperture into the inner trabecular space are at first destitute of a trabecular framework.

In all the numerous Lyssacina, which, like *Acanthascus* (Pls. LVI.–LVII.), *Rossella* (Pl. LV.), &c., resemble a thick-walled beaker or cup, the folding of the chamber layer is continued by the formation of successive protrusions, so that branched efferent passages of roundish section are formed, between which corresponding complex incurrent passages penetrate inwards from the outer trabecular spaces. This development of a more or less richly branched system of afferent and efferent passages, which are, however, completely separated by the chamber layer, remains essentially unchanged, even with such

complicated folding of the chamber layer as occurs in the very thick-walled species *Pheronema* (Pls. XLII.–XLVI.) and *Poliopogon* (Pls. XLVII.–L.). The efferent canals do not, however, by any means, always remain free from the trabecular framework which is so abundantly developed in the afferent spaces. This is very frequently illustrated, as, for example, in *Malacosaccus* (Pls. XVIII., XIX.), *Crateromorpha* (Pls. LXI.–LXIII.), *Hyalonema* (Pls. XXVII.–XLI.), *Polylophus* (Pl. LIV.), *Rossella* (Pl. LV.), and others, where a reticular lining penetrates from the subgastral trabecular space into the outermost diverticulum of the efferent canal system, without, however, at any time crossing the lumen of the efferent passages, or entering the cavity of the chambers. The gastral membrane extends smoothly over all the (excurrent) openings of the efferent canals, in the form of a sieve-like net, and thus forms the boundary of a simple gastral space, as in *Rossella* (Pl. LV.), *Pheronema* (Pls. XLII.–XLVI.), &c.; or it lines the niche-like depressions of the wall which may be of simple or complex form, as in *Malacosaccus* (Pls. XVIII., XIX.); or finally it passes through the wide excurrent openings of greatly branched efferent canals which open directly into the gastral space, and extends within them on to the terminal branches, as in *Hyalonema* (*Stylocalyx*) *depressum* (Pl. XXXVI. fig. 1) and others.

Further variations of the simple saccular form are exhibited by many Hexactinellida in the formation of a *terminal sieve plate* covering the wide opening at the extremity (*Euplectella*, Pls. I., V., *Holascus*, Pls. XV.–XVII., *Hyalonema sieboldii*, Pl. XXVII., and others). In many cases, too, the body-wall exhibits a more or less regularly arranged set of gaps, by means of which a direct communication is established between the gastral cavity and the external medium. While these gaps in the walls of *Euplectella* (Pl. I.) and *Tægeria* (Pl. VII.) are circular, and bounded by an iris-like membrane which is capable of contraction, in *Walteria* (Pl. IX.) they occur as irregularly angular meshes, like the lattice-work of a basket. Striking modifications may arise by the formation of a stalk, which is, indeed, always in the form of a simple continuation of the lower portion of the body-wall, from which, however, it often differs widely in diameter. It varies greatly in the length attained, and is more or less sharply truncated. The stalk is generally quite round and smooth, but frequently with characteristic curvature (*Caulophacus elegans*, Pl. XXV.), or prominent protuberances (*Crateromorpha murrayi*, Pl. LXIII.), and is sometimes even branched (*Sympagella nux*, Pl. XXII. fig. 4). It is either solid or tubular, generally the latter in long stalks (*Caulophacus*), and its lumen either opens into the gastral cavity, or is in communication with, and so belongs to the efferent canal system. By the expansion of the upper oscular margin many species, *e.g.*, *Rhabdocalyptus mollis* (Pl. LXIV. fig. 1) and others, acquire a funnel-like shape. A further widening and flattening leads to the formation of a flat saucer-like body, while a more unilateral growth results in an ear or shell-like form (*Euryplegma auricularis*, Pl. CII.), or even in certain circumstances in a simple perpen-

dicular plate-like form (*Chonelasma*, Pls. LXXXVII.-XCI.). The wall of the cup may be complicated by thimble-like sacculations, as in *Aphrocallistes bocagei* (Pl. LXXXIII. fig. 1), and, in such cases, the gastral cavity may be separated by several transverse net-like diaphragms into a series of partitions. If the outer margin of a stalked, originally cup-shaped sponge, becomes folded outwards and downwards through great development of the median portion, a fungoid form arises which, in the genus *Caulophacus* (Pls. XXIV.–XXVI.), exhibits several varieties of outline. In this way then, as the gastral cavity and osculum have thus been lost, what was originally the internal gastral has become the upper and outer surface, so that the water enters the body from below, and escapes again from the upper outer wall. In *Aulochone* (Pls. LXVI., LXVIII.) the originally upper portion of the gastral membrane has, on account of the folding of the oscular wall, been turned towards the outside, and thus forms the outer wall of the cylindrical or approximately hemispherical body, while the under portion of the gastral cavity along with the lumen of the tube-like stalk connected with it, has remained unchanged.

In many Dictyonina the elongation of the sac-like body, without any marked thickening of the wall, results in the formation of more or less thin-walled tubes in which the lumen remains approximately the same. These tubes often branch in a tree-like fashion, frequently dichotomously (*Aphrocallistes ramosus*, Pl. LXXXVI. fig. 1), while the multiplication and union of branches may form an anastomosing network of tubes, from which numerous terminal branches arise, each provided with an osculum. The latter is the state of the case, *e.g.*, in the genera *Farrea* (Pls. LXXI., LXXII.) and *Eurete* (Pls. LXXVII.–LXXIX.). In *Farrea* the young tube-wall begins on the outermost terminal branches as a very thin plate with a simply folded chamber layer, and the whole wall is gradually somewhat thickened, with the increasing folding of the chamber layer; while in *Eurete* the ends of the tubes are continuous outgrowths of the entire thickness of the wall.

The main tubes in expanding into a funnel-shape sometimes give off lateral branch-tubes, which have a tendency to branch and anastomose, as in *Periphragella* (Pl. LXXX.) and *Aulocalyx* (Pl. LX.). In some species, which consist, for the most part, of a net-like system of anastomosing tubes, with terminal and lateral oscular openings, a special covering layer may occur which envelops the whole body, and which, as an independent plate, not only spreads out laterally from the oscular walls as a fine porous skin or net-like sieve for the inflowing water, but also extends over the oscula as a sieve plate, with wider apertures. This remarkable structure, which may be termed a cover, is seen in *Aulocystis* (Pl. CIV.), and also, though in quite different form, in *Semperella* (Pls. LI., LII.), where the oscula appear, not so much as round apertures, but rather as irregular longitudinal clefts on the sides of the body. The covers of these genera differ also in this: in *Aulocystis* the cover appears as a direct continuation of the entire wall

of the tube (though without the chambers); in *Semperella*, on the other hand, the cover consists, in that portion which is spread over the afferent passages, simply of the uplifted external skin, while the sieve plates extending over the oscular clefts appear as a chamberless continuation of the entire wall of the tube.

HISTOLOGY.

Though the material placed at my disposal for investigation was not very well suited for histological research, some facts of interest were established. It ought to be observed, in the first place, that the histological structure is so uniform throughout the entire group, that the modifications to be noted are hardly of an important character.

As I pointed out in my communication On the Structure and Arrangement of the Soft Parts in *Euplectella aspergillum*,[1] the Hexactinellida exhibit, like all other Sponges, three histological layers, viz., two distinct layers of epithelium, and an intermediate connective tissue with various substances enclosed within it. As to the delicate single layer of flat epithelum which covers the entire surface exposed to the water, I have not been able to detect the contours of the cells, but simply their characteristic, small, clear, spherical nuclei. These, and the small, shining, granule-like nucleolus, were distinctly recognisable on well-preserved portions of the surface when strongly stained with hæmatoxylin or picrocarmine. The nuclei are distributed with tolerable uniformity, and project a little above the general surface of the cell, as is indisputably demonstrated on profile view. They thus lie in the very outermost portion of the bounding surface. This can be best seen on the dermal and gastral limiting membranes, but these epithelial nuclei are also recognisable as slightly projecting elevations, on the netted strands of the subdermal and subgastral trabecular spaces, and also on the trabeculæ and membranes extending between the ciliated chambers (Pl. IV. fig. 8).

A peculiar character, which differs not inconsiderably from the known relations of other Sponge groups, is exhibited by the epithelium which lines the inner surface of the chambers. One could not, of course, expect that in these epithelial cells, structures so delicate as the flagellum and collar should be preserved. Although I have taken every trouble, I have failed to detect these structures which are so constant in the chamber-cells of all known Sponges. It cannot be doubted, however, that they were really present. In my variously stained preparations, the chamber-cells appear as small bodies, projecting for a variable distance into the lumen of the chamber, and provided with small spherical nuclei and usually with a single shining nucleolus, which is sometimes of a cylindrical, but usually of a kidney-shaped roundish form. The remarkably regular disposition of these cells, and their connection by flat lateral bands, which extend over the membranous chamber-wall, are worth noting. Since

[1] *Trans. Roy. Soc. Edin.*, vol. xxix., 1880.

these bands are disposed in rows, intersecting approximately at right angles, at an average distance of 0·06 mm., and united further by stronger basal strands, a lattice-like pattern results, in which the meshes are approximately rectangular or slightly rhombic in form. As to the nature of the somewhat strongly refracting and slightly stained connecting strands, of which the stronger cross at right angles, while the finer branches are irregularly reticulate (Pl. LXII. fig. 8), I have not been able to come to a perfectly clear decision. I have little doubt, however, that we have here to do with the anastomoses of protoplasmic processes from adjacent cells. Each cell seems to be connected with its four neighbours by one main connecting process and several fine lateral branches (Pl. LXII. figs. 7, 8).

The connective substance, which forms the main framework of the soft body, does not differ essentially from that of most other siliceous Sponges. In the hyaline, somewhat soft matrix, two kinds of cells can be distinguished, namely, (*a*) simple stellate or spindle-shaped connective-tissue cells with little protoplasm, and a small oval nucleus, and (*b*) larger cells with clear vesicular nucleus, and with a more or less abundant accumulation of refracting, intensely stained granules of various sizes. As a rule, these granules lie loosely beside one another, and may be included in lappet-like processes of the cell (Pl. IV. fig. 8, and Pl. LXII. fig. 8). Sometimes, however, they are united in firm clumps. Occasionally I found them brownish or yellow in colour. As I have previously noted, I regard these bodies as reserve nutriment, analogous to fat or starch. Small groups of round cells occasionally occur, but their import is not known (Pl. LXII. fig. 8).

All the skeletal structures belong exclusively to the connective-tissue. On the surface of the spicules there is a more or less distinct thin layer of hyaline matrix, the so-called spicular sheath, which, on specially thick needles, is seen as a finely fibrous membrane. In the connective substance, finally, the genital products occur, the sperm masses and ova, in more or less abundance, and usually in the same individual. The sperm masses, both in young and mature stages, are exactly like those of other siliceous Sponges, such as *Reniera*. In their immature form the ova are indistinguishable from connective-tissue cells. They subsequently increase in size and develop refracting yolk granules, and exhibit a very characteristic aspect owing to the enlargement of the nucleus. It is remarkable that in the adult (0·3 mm. in diameter), irregularly roundish ova of *Euplectella aspergillum*, along with which ripe sperm masses also occurred, the nucleus was situated not in the ovum itself, but lay freely in a superficial depression into which it had been squeezed. This expulsion of the nucleus was probably the result of the drastic preservative treatment.

It is curious that I have never been able to discover any distinct segmentation stages. It would not, however, be justifiable to jump to the conclusion that the ova leave the body of the Sponge as such, and undergo subsequent development outside the mother organism.

As to the developmental history I am only able to communicate a few observations.

Some species undergo multiplication by budding. This process can be studied extremely well in *Polylophus philippinensis*, where the same specimen frequently exhibits numerous stages in the development of buds, from small papilla-like elevations to adult individuals ready to be separated off (Pl. LIV. fig. 1). After the numerous conical protuberances of the lateral surface, which are apically equipped with a tuft of slightly divergent needles, have grown out to a greater length, and have been drawn out into nipple-like structures, they become constricted, and the outer portion expands into a pear-like form. The bud continues to grow gradually larger, expanding especially on its free terminal portion; a roundish opening is formed at the distal pole, while on the lateral surface a number of conical projecting tufts of needles appear irregularly disposed. The portion connecting the bud with the mother Sponge becomes longer, and at the same time thinner; finally the union between the two is wholly severed, and the bud thus separated is attached only by a weak bundle of siliceous needles. Strain and friction soon effect complete separation, and the bud at length falls to the ground, where it becomes independently attached by its own tuft of spicules (Pl. LIV. fig. 1).

When, in such a process of gemmation, the undeveloped individuals remain attached by an elongated stalk, ramified colonies with terminal individuals result, as for example in *Sympagella nux* (Pl. XXII. fig. 4).

These young buds are in their young stages admirably suited for investigation, affording a convenient view of the whole organisation of the form in question. This may be illustrated by glancing at fig. 2 on Pl. LIII., where a longitudinal section through *Polylophus philippinensis* is represented. The relation of the entire chamber layer to the general canal system and water stream becomes at once distinct. It may be clearly seen that, however much the layer of chambers is folded, it always forms a continuous intermediate layer between the afferent and efferent lacunæ or canals, forms in fact a filtering layer, through the pores of which the stream of water has to pass.

The above gemmation which results from proliferations of the sponge-wall, must be of course distinguished from a formation of colonies very frequent among Dictyonina, which occurs, however, as the result of the folding of the exuberant margin of a cup or tube-like rudiment. The dichotomous or more complex tubes, which frequently exhibit lateral branches, in *Farrea*, *Eurete*, *Periphgragella*, *Myliusia*, &c., result wholly from the folds of the growing portion becoming gradually closed into complete tubes (Pl. LXXII. fig. 3; Pl. CIII. figs. 1, 2) as may be readily demonstrated from a careful comparison of the different stages in the development of the colony.

In some cases, as for example in the young specimens of *Lanuginella pupa* (Pl. LIII. figs. 4, 5) which were found isolated, I was of the opinion that I had before me very young forms developed from the ovum. I inferred that chiefly from the fact that both the youngest, simply spherical specimen (2·3 mm. in diameter) (Pl. LIII. fig. 4), and a

somewhat larger oval form, were surrounded by a perfectly continuous skin, and exhibited no trace of a connecting stalk. The chamber layer in the former case was still simply a closed sphere, while in the second a rupture had taken place towards the pointed pole of the oval body, at the point apparently where the osculum would be developed. A beautiful post-embryonal series, with certain modifications of form, was observed by Wyville Thomson[1] in *Pheronema* (*Holtenia*) *carpenteri*.

Generally speaking, however, no important modification in the form seems to occur during the development. In those Lyssacina in which the spicules are never soldered together, the growth may apparently continue until the death of the animal; so that giant forms of 50 cm. in diameter and more may arise, as *Poliopogon gigas*, *Malacosaccus vastus*, &c. In many Lyssacina, however, which, as they grow, typically exhibit a soldering of the principal needles, there appears to be a definite limit of growth (*e.g.* in *Euplectella aspergillum*). It is readily intelligible that when the soldering of the needles has progressed from the median portion of the tube to the basal tuft on the one hand, and to the firm terminal sieve-plate on the other, any further extension of the sponge-body is really impossible. It is different with the Dictyonina, in which the principal needles (Dictyonalia) are immediately after their formation united with one another into a connected framework. Here, however, both on the free margin of the cup- or tube-like body, and on the whole dermal and gastral surface, there is a persistent continuance of growth through the laying down of fresh portions of the framework and simultaneous displacement of the loose dermal and gastral skeleton. It is only when the dermal skeleton becomes itself rigid, through the union of its spicules in a reticulate framework, or by a continuous siliceous membrane, that an absolute check is placed upon any further lateral growth. This seems also to occur in individual cases, *e.g.*, in *Fieldingia*, and with apparent regularity in several fossil forms.

In many species the whole body dies and falls to pieces at once, while in others dissolution is more gradual and begins at the base. Thus many specimens, especially of Dictyonina, and also many Lyssacina, are dead in their basal portion, which consists simply of a perfectly macerated skeleton, representing either the loose fibrous tuft, as in *Poliopogon amadou*, or a dead portion of the dictyonal skeleton. The latter case is illustrated in Pl. CII. fig. 1, in reference to *Euryplegma auricularis*, where the lower boundary of the persistent, somewhat darker soft body is sharply marked off. On a large beautifully developed specimen (40 cm. in height) of *Aphrocallistes vastus*, which Dr. Gotsche brought from Japan, the whole basal portion for about a hand's length has been killed. The siliceous elements rooted in the mud are not, however, always wholly dead. The long tuft needles of the Hyalonematidæ and the anchor needles of the Euplectellidæ undoubtedly retain their life, being probably nourished through the strand of their axial canals.

In all skeletal elements which have been exposed, for a lengthened period after

[1] *Phil. Trans.*, vol. clix. p. 70.

death, to the influence of sea-water, one always notices a more or less marked widening of the axial canal. This is due to the fact that the central siliceous layers are slightly more soluble than the outer. The time that has elapsed since death can thus be approximately estimated, and the differences have, of course, no systematic importance as was formerly supposed.

THE SKELETON.

Under the title *skeleton* I include all the solid parts of the Sponge, whether these are bound together into a united framework, or lie isolated in the soft tissues. I would avoid the expressions, "skeletal" and "flesh" spicules, which are much used by Carter, Zittel, and others to distinguish the hard parts into two leading categories; since, on the one hand, these expressions are ambiguously used by different authors, and even by one and the same author, and, on the other hand, since they in no way indicate any essential distinction. By "spicules of the skeleton" Carter originally understood "large spicules, which are only concerned in the formation of the supporting structure or skeleton," but he subsequently applied the term only to the *larger free spicules,* in contrast to the *smaller free spicules* or "*flesh spicules,*" and to the *vitreous fibre* of the continuous lattice framework. Zittel used the phrase "*skeletal spicules,*" for the most part in reference to the skeletal parts concerned in the formation of a united lattice-like framework, but he occasionally applies it also to the larger free spicules which form the chief support of the soft parts.

Most spicules present a structure similar to those which Max Schultze and Claus first discovered in the larger spicules of *Hyalonema sieboldii* and *Euplectella aspergillum.* A fine central canal, corresponding to the typical axes of the skeletal body, is surrounded by numerous concentrically arranged layers of a solid substance. In its appearance and other physical properties the latter resembles glass so closely that it has been often, without the least hesitation, spoken of as *vitreous fibre.* For the same reason the entire Hexactinellid group has been designated "vitreous sponges," or more shortly "Vitrea." As to the nature of the soft, finely granular mass composing the axial thread or cord which fills the central canal, but little is as yet known. During the growth of the spicule it appears to be connected with the surrounding soft parts through an opening which is present at the end of every ray. After the ray has ceased to grow in length, the terminal opening is closed by an expansion of the layers of the glassy substance. That all spicules have a central canal is very probable, but not quite certain, since it has not been possible to recognise it in all cases. Especially in very thin and small spicules it is often very difficult or impossible to detect it. I have never found it in lateral prickles, prongs, scales, and the like, nor in the secondary terminal rays of the rosettes and scopulæ, nor in the short transverse connecting beams,

the so-called "synapticula," which stretch so frequently between neighbouring spicules of many Lyssacina, binding them into a solid framework, nor finally in those remarkable lattice networks which occur in many Hexactinellida on regions in contact with foreign bodies, but especially where the Sponge has grown on a solid substratum. In individual cases, as, *e.g.*, in the thickened extremities of many anchor spicules, the central canal exhibits a brush-like division into several diverging, blind, terminal branches (Pl. III. fig. 29; Pl. XIV. fig. 5).

The innermost layer immediately surrounding the central canal is called by Claus the "*axis cylinder*." It is generally distinguishable from the usually many layered outer cortex by its somewhat feebler refractive power and by the absence of lamination. From the behaviour of the spicules when heated, and when examined in polarized light, Max Schultze determined that the individual lamellæ were separated from each other by thin layers of an organic substance. After cautious heating, fine brown carbon streaks were seen between the adjacent hyaline layers. By the use of the polarising apparatus double refraction could be demonstrated in the thin intermediate layers, but not in the substance of the lamellæ.

Professor Maly of Graz was kind enough to analyse a number of spicules from the root tufts of a *Poliopogon amadou*, and has summed up the result in the following note, with which he has favoured me:—"The spicules after being placed in a desiccator, and dried at 105°, still contained 7·16 per cent. of water in chemical union. They are, therefore, not silicic acid in the mineralogical sense (quartz substance), but a hydrated silicic acid, and therefore resemble opal, in which the amount of water very frequently varies from 6 to 8 per cent."

In no other group of Sponges is there so great a variety in the form of the skeletal elements as in the Hexactinellida, yet nowhere are the numerous individual forms of the spicules so readily referable to a common fundamental type.

As was first recognised by Wyville Thomson, and subsequently abundantly confirmed by Oscar Schmidt, Marshall, and others, a system of three equal axes intersecting at right angles is the fundamental structure of the skeletal parts in all Hexactinellida, and that both in regard to the spicules united into a continuous framework, and those which lie isolated. Though the disposition of the axes is thus in fundamental agreement with that of the regular crystallographic system, the structure of the spicules is by no means the result of crystallisation. The silicic acid occurs here in an absolutely amorphous condition like that of the opals with which they are, chemically, so closely related. Only in a few fossil specimens does the existence of double refraction indicate a secondary transformation into the crystallised state.

The axes of the individual skeletal elements are usually quite distinctly indicated by the disposition of the principal rays in relation to the point of intersection, but frequently they can only be demonstrated by examination of the central canals.

The fundamental form of all the spicules is the simple, regular, six-rayed form. The manifold deviations from this form may be understood as the results of the following modifications:—(1) the unequal development of the rays, which may lead to the complete suppression of one or more, so that in extreme cases only a single ray attains full development; (2) division of the rays into terminal branches, varying in number, form, and direction; (3) the development of local thickenings or unilateral swellings in the form of knobs, thorns, prickles, knots, and similar ornamental protuberances; (4) the curvature of the chief rays or their branches.

The isolated spicules which sometimes occur, in which more than six principal rays seem to run out from a nodular point, may be usually referred to a very deep division of one or several of the principal rays, as the result of which the secondary or terminal rays have been closely approximated to the point of intersection, and thus simulate the principals (Pl. XCVII. fig. 3).

In many cases in the continuous frameworks, more than six beams are seen running out from a nodular point, but of these, as is well known, only six belong to one spicule, while the others belong to neighbouring hexacts, and have become fused to the former spicule at the node of intersection.

In our survey of the different forms of spicules which occur in the Hexactinellida, it will be convenient to divide them into six main groups, according to the number of perfectly developed rays. These six forms may be termed Hexacts, Pentacts, Tetracts, Triacts, Diacts, and Monacts, and they will be treated consecutively in that order.

Hexacts.

Regular Hexacts are all spicules in which the rays lie at right angles to one another, and are of equal length and similar form. One of the most simple and at the same time most frequent of the regular hexacts possesses straight, perfectly round and smooth rays, in which the diameter becomes uniformly less from the point of intersection to the extreme tips (Pl. III. fig. 15; Pl. XXVII. fig. 20). Even in these simple forms, however, there are manifold differences in the size of the radii. Besides the gradual running to a point, the rays frequently exhibit an irregular decrease of the diameter towards the outer extremity. The latter may thus be conically sharpened, rounded in various ways, or transversely truncated. The ray may also exhibit a terminal swelling of varying form, a sharply truncated terminal knob (Pl. XCV. figs. 3, 4), or a hemispherically arched, transverse, terminal disc provided with marginal prongs (Pl. XI. fig. 3; Pl. LV. fig. 8). In the latter cases there is no manifest decrease in the diameter of the ray from within outwards.

The rays may be roughened by small elevations thickly studded throughout their whole length (Pl. LV. fig. 5), or in particular regions (Pl. LII. fig. 5). They are often

also beset with thorns and prongs, varying in form, size, and direction (Pl. LVIII. fig. 6; Pl. XI. fig. 2; Pl. XXVII. fig. 13; Pl. XVI. fig. 8).

In certain cases, as Marshall has shown, individual thorns become greatly developed, are directed obliquely inwards, and unite with the opposite thorns of other rays on the same hexact. This results in the remarkable formation of octahedral margins round the intersections of the lattice-like framework in many fossil, and also in some living Hexactinellida (Pl. CIV. fig. 3).

The rays of most regular hexacts are straight, but curved forms often occur. The curvature may be quite irregular and undulating, but it has in most cases a definite form and direction, varying in different species of Sponges, and in many instances characteristic. The curved rays may be smooth or rough, and are sometimes also beset with prickles (Pl. XXVII. fig. 10). When the rays run out to a pointed extremity, the name "*oxyhexact*" may be applied. When a knob or disc-like thickening is formed at the end of each ray the term "*discohexact*" may be conveniently used.

In many regular hexacts secondary rays appear, either as diverging and similar terminal branches on the principal rays, or arranged in a circle or a disc-like transverse expansion of the latter, or finally they may be uniformly distributed close to one another. To such hexacts, provided with secondary or terminal rays, Carter has applied the term "*rosette*." The number of terminal rays on each principal is generally constant in one and the same kind of rosette, though it may occasionally vary in different rays, even on the same rosette, and on different rosettes otherwise similar. Variations in the form, direction, and dimensions of the terminal rays result in numerous kinds of rosettes.

The length of the terminal rays is generally in inverse ratio to that of the basal principals, which are, as a rule, cylindrical and smooth, and less frequently rough or beset with prongs (Pl. LXXXVIII. figs. 8, 9; Pl. XCI. fig. 7). The terminal rays are sometimes smooth, sometimes rough (Pl. XXIV. fig. 6), or covered with prongs (Pl. XXV. fig. 6), sometimes straight, sometimes bent in different ways, but usually in such a way that the planes of curvature in all the terminal rays are directed radially towards the axis of the principal. If the curvature is simple, either its concavity or its convexity may be directed towards the principal axis; if it is S-like the terminal ray bulges in its proximal or inner portion towards the exterior, while the distal outer portion has its convexity turned towards the axis of the principal, and bends outwards like the petal of a lily. The terminal rays are seldom quite cylindrical, in many cases their diameter decreases towards the free ends, in other cases the converse is observed. The very end may be pointed, truncated, rounded off, or terminated by a sharply truncated terminal expansion of a knob-, cylinder-, disc-, or bell-like form.

As to the abundant rosettes, it is convenient to distinguish in the first place those forms in which the principal rays are wholly or partly divided into two or more uniformly

pointed, outwardly directed, and divergent terminals. Such forms I have designated "*oxyhexasters*." All the six principal rays are usually divided into an equal number (two to five or more) of terminals, but the number of the latter may vary in the different principals even in one and the same oxyhexaster; and it may even happen that individual principals remain undivided. In the extreme case (Pl. LVI. fig. 8), only one of the six principals is forked, while the other five run out to simple points. It is noteworthy that, in a division of a principal ray, the divisional planes of the two principals which are directly opposite to one another, and therefore belong to one axis are mutually disposed at right angles (Pl. LVI. fig. 7). The terminal rays of the oxyhexaster are usually straight (Pl. III. fig. 1; Pl. XVII. fig. 8), but slight curvature frequently occurs. In such cases the rays are either simply convex internally or externally (Pl. XXI. fig. 6; Pl. XIII. fig. 6), or they are S-shaped (Pl. LXII. fig. 5). The terminal rays may be sometimes quite irregular and wavy, or else hook-like (Pl. XIV. fig. 13; Pl. XV. fig. 9), or even sharply bent (Pl. XXVI. fig. 7).

Striking forms which occur in many Euplectellidæ and here and there in *Crateromorpha*, may be termed brush-rosettes, "*graphiohexasters*." The principal rays are much broadened and bear a bundle of long, straight, thin, terminal rays in parallel or slightly diverging disposition (Pl. XV. fig. 19; Pl. XII. fig. 5). A closely related form, distinguished, however, by the slightly waved curvature of the delicate terminals, is represented in Pl. CIV. fig. 4. In many rosettes with numerous S-like terminal rays, disposed in concentric circles, there is a certain resemblance between the tuft of rays, and a down-feather or *pluma*. I have, therefore, called these forms "plumicomes." Their individual terminal rays may run to a point at the outer extremity, or becoming gradually thickened towards the curved ends, be rounded off terminally (Pl. LIV. figs. 4, 6).

A perfectly uniform increase in the thickness of the straight terminal rays, on to the broad, rounded, free extremity, is exhibited by an unusually large form of rosette, which is also further characterised by a fringe of strongly bent hooklets (Pl. LX. fig. 3). Another form, represented in fig. 2 on Pl. LXX., is characterised by the sharply truncated cylindrical thickening of the outer part of the straight terminal rays, which thus exhibit a certain resemblance to the spikes of a *Typha*.

In the rosettes with rounded terminal knobs, "*sphærohexasters*," the terminal rays occur in varied form. They may be quite straight (Pl. CI. fig. 7), simply curved, S-shaped (Pl. XCI. fig. 7), or finally irregularly curved in a wave-like fashion (Pl. LXXVIII. fig. 12). They are of equal thickness throughout their whole length.

Where transverse terminal discs are developed in the discohexasters, the stalks seldom retain a cylindrical form (Pl. XII. fig. 4), but are as a rule thickened either externally or internally (Pl. XII. fig. 8; Pl. XIII. fig. 3). The terminal discs are fixed transversely on the corresponding terminal ray by their centre, or they may form an over-

hanging expansion of the curved outer end of the ray. In the former case they are radially symmetrical, in the latter bilaterally symmetrical, with a plane of symmetry, indicated by the S-shaped curvature of the terminal ray.

Although the radial terminal discs vary greatly in form, they all agree in this that the outer terminal surface is convexly arched or conical, while the lateral margin is provided with small teeth or longer protuberances. If the marginal teeth are large in relation to the central body of the disc a many toothed anchor form results (Pl. XXV. fig. 6). If the middle portion of the anchor, on the other hand, is more strongly developed, the result is a hemispherical form with a toothed margin, or a campanulate form with long marginal protuberances (Pl. XII. fig. 4). The number and form of the marginal teeth varies in different rosettes. It is frequently four, but in other cases six, eight, twelve, or indefinitely more.

To all rosettes in which the secondary rays bear on their ends a transversely directed, radially symmetrical terminal disc, I would apply the term "*discohexasters.*" Those forms, however, in which S-shaped terminal rays bear on their ends a bilaterally symmetrical disc-like thickening, I would call "*floricomes*"—a term used in reference to the resemblance of the bundle of rays to a flower perianth, and first employed by Bowerbank in the description of *Euplectella aspergillum.* In these floricomes the formation of small marginal teeth is usually confined to the terminal portion of the disc-like thickening that projects or overhangs externally (Pl. III. fig. 11; Pl. XIX. fig. 5), so that a hand or claw-like form arises. In other instances small teeth are formed over the whole margin of the disc-like thickening (Pl. XVIII. figs. 6, 7).

With these regular hexacts numerous irregular forms are contrasted. The latter are characterised by the variable formation of one or more rays; the distinctions are associated with difference in length of ray, or with modification of form. To the first category belong the sword-like hexacts, which are found beneath the skin of many Euplectellidæ, such as *Euplectella aspergillum,* (Pl. III. fig. 10), *Euplectella crassistellata* (Pl XII. fig. 4), and others. In these the five outer rays are simple, smooth, round, and run out to a point; they are either altogether or almost exactly of equal length, while the sixth ray, directed inwards, is also smooth, round, and pointed, but is fully twice as long as the others. Frequently, too, besides the ray directed inwards, the outer radius on the same axis is longer than the tangentials, so that the resemblance to a cross-hilted sword may become very obvious, as in *Tægeria pulchra* (Pl. XI. fig. 5). This lengthening of the rays, in one or in two axes, is quite frequent, *e.g.*, in those hexacts with long thread-like rays, which are found so abundantly in the parenchyma of *Malaccosaccus vastus.* In this form the two rays on the radial axis are usually shorter than the four tangentials. The inverse relation occurs in the hexacts which lie in the gastral membrane of *Asconema setubalense*, where the two rays of the radial axis are *longer* than the four tangentials (Pl. XXI. fig. 5).

The shortening of *one* of the six otherwise similar rays is very frequent, and leads finally to the formation of pentacts.

Much more frequent, however, than mere differences in length, are modifications of form. A ray may, in its entire configuration, more or less markedly differ from its five neighbours. This is the case, *e.g.*, in many hexacts with fir-tree-like distal rays, *pinuli*, such as occur in the skin of *Aulascus johnstoni* (Pl. XXII. fig. 3), *Caulophacus elegans* (Pl. XXV. figs. 4, 5), and many other Asconematidæ, and also in *Aphrocallistes* (Pl. LXXXIV. fig. 8; Pl. LXXXV. fig. 4). More frequently, however, the differentiation affects two radial rays generally on one and the same axis, as is usually the case in the hexacts which occur in the skin of the Asconematidæ, and are provided with one prominent, scaly, fir-tree-like, pronged ray (Pl. XXII. fig. 9; Pl. XXVI. fig. 9). Similar forms occur also in many Euplectellidæ (Pl. XII. fig. 3; Pl. XIII. fig. 2). Apart from the differences already noted, in regard to the rays of many rosettes, some other hexacts, with secondary rays, exhibit further irregularities. Thus, *e.g.*, *Aphrocallistes beatrix*, Gray, is markedly distinguished by the character of the spicules which lie separately in the soft parts. In these, two of the principal rays, not however on the same axis, are elongated and curved, and occasionally divided into four pointed terminals, while the four other principals remain simple and short (Pl. LXXXIV. figs. 9, 10).

Pentacts.

In support of the theory that pentacts have phylogenetically arisen from hexacts by the atrophy of one ray, the existence of numberless transitional forms, with a more or less manifest rudiment of the sixth ray, may be adduced; while it ought to be noted that the disposition of the five well-developed rays is in thorough agreement with that of the corresponding rays in hexacts and, finally, that pentacts occur almost exclusively close to the bounding layer, where the development of one of the two rays standing at right angles to the limiting surface, is either impeded or specially favoured. Either the distal or the proximal ray may thus undergo atrophy, with the associated increase of the other.

The rays may be smooth (Pl. LVI. fig. 6), or rough (Pl. LV. fig. 3), cylindrical or attenuated towards the exterior, and pointed, rounded, or even thickened at the extremity.

The simple case in which all the five rays are of equal form and size is of frequent occurrence (Pl. LV. fig. 3), but the unpaired ray usually differs in some point from the four others. It may project freely beyond the bounding surface, bearing lateral prickles which overlap one another like scales. The resemblance to a fir-tree, thus produced, has earned for the entire spicule the designation *pinulus*. Such pinuli, in which

the sixth ray may also appear, occur typically in the two families of the Asconematidæ and Hyalonematidæ. Further differences between the unpaired fifth ray and the other four occasionally occur.

As in hexacts, so here curved rays often occur, and the ray may be curved throughout its whole length, or only in a particular portion. The curvature is frequently exhibited only by the four rays which form the cross, and these are usually curved towards the unpaired straight ray (Pl. LXXIV. figs. 1, 2). In many of the pentacts, which project from the sponge-body, this curvature of the four cruciate rays has been so effected that they have assumed an anchor form, and have, in fact, the function of an anchor (Pl. III. fig. 23; Pl. XXXIII. fig. 10).

Peculiar curvatures of a different kind are exhibited by the four cruciate and tangential rays of many pentact pinuli, which adhere closely to large siliceous beams of hypodermal spicules (Pl. LII. fig. 6).

The four rays, which lie at right angles to the two radials, form an acute angle with each other, and are sharply curved just at their origin in those large pentacts of *Rossella antarctica* (Pl. LV. fig. 9, 13), which have been protruded from the outer skin of the lateral wall.

In the fork- or broom-like spicules (*scopulæ*), which frequently possess four outwardly directed teeth in addition to the long stalk, I was, like O. Schmidt, unable to trace into the teeth the fine axial canals, though their cross of intersection is often very plainly visible just below the forking. It seems to me improbable, therefore, that the teeth can be regarded as principal rays, and all the more since their number is by no means always four or five, but sometimes six or more (Pl. XCII. figs. 4, 6; Pl. XCIV. fig. 5). I should be more inclined to compare them with the terminal rays of the rosettes. The invariably simple and straight stalk of the scopulæ either ends in a point, or is truncated, or exhibits a knob-like thickening. It is usually smooth, being but rarely provided, terminally or throughout, with tubercles or transversely directed prongs. The teeth, on the other hand, exhibit manifold variations in number, length, form, and position. They usually arise in whorls from, or just above the knot-like swelling on the stalk which contains the axial cross. They usually vary in number from four to six, but in individual cases more may be present. Sometimes they diverge but slightly at their point of origin (Pl. LXXXIV. fig. 5), and, in other cases, somewhat widely (Pl. XCVIII. fig. 8). After their original divergence they may also become parallel to one another, and to the chief axis (Pl. XCVIII. fig. 9). They are frequently simple in the gastral part, but exhibit in the dorsal part an S-like curvature (Pl. XCII. fig. 6), or are sharply bent somewhat above their origin, so that the outer portion is considerably divergent (Pl. LXXVII. fig. 10; Pl. XCIV. fig. 5). Some are pointed (Pl. LXXVIII. figs. 3, 5), and others truncated (Pl. XCII. figs. 5, 7), but most of them bear a knob-like or even spherical terminal swelling, which is usually provided with numerous fine backwardly

bent prongs (Pl. LXXIX. figs. 4, 5; Pl. LXXXIV. fig. 4). These finely pointed prongs often occur over the whole branch (Pl. XCII. fig. 5), or on special portions of the same (Pl. LXXXIV. figs. 3, 5). I am, on the whole, inclined to regard the scopulæ not as pentacts, but rather as diacts or monacts.

Tetracts.

If two of the six rays of a hexact on the same axis are not fully developed, simple cruciform spicules arise, with four rays in the same plane. Such regular tetracts occur in the outer, and in the inner (gastral) membrane of many Rossellidæ; as also on the lower end of the body of *Hyalonema*, in the quadrate latticework of the main supporting framework in many Euplectellidæ, and in many other species. Rudiments of the two rays which have not been fully developed can be detected at the nodes of intersection. Such regular tetracts are either quite smooth, or uniformly rough (Pl. LVI. fig. 5), or beset with knobs. Many, however, are only rough or knobbed terminally. Some are more or less uniformly pointed, while others are truncated, rounded, or provided with a knob-like thickening. The four rays are not always equally long (Pl. III. fig. 28; Pl. XXXV. fig. 8). In many tetracts they are wholly or partially curved, and that either in the plane of the cross (Pl. III. fig. 27; Pl. XXXI. fig. 15) or in a spherical form (Pl. LIV. fig. 7). A few cases occur, which seem to have arisen, not by the abortion of two opposite hexact rays, but of two rays at right angles. In such forms only one of the three typical axes is fully developed, and of the two others only one ray of each has remained (Pl. III. fig. 20).

Triacts.

The three rays of a triact usually lie in the same plane, and consist of two rays belonging to one axis with a third at right angles to these. They are either straight or slightly bent, quite smooth or terminally rough, besides being frequently swollen and knobbed. While the rays of the main axis are generally equal, the unpaired third ray is usually distinctly shorter (Pl. III. figs. 12, 25), and seldom larger (Pl. III. fig. 26) than the others. The insertion of this unpaired ray is often opposite a prong, which doubtless represents an abortive fourth ray (Pl. III. figs. 19, 28). If the unpaired ray is very long, and the two others are bent towards it, a peculiar anchor form results, such as may be seen among the prominent lateral, and basal-tuft spicules of many Hyalonematidæ, such as *Pheronema*, *Poliopogon*, and *Semperella* (Pl. XLVIII. fig. 14*a*).

Rarely it happens that all the rays are markedly curved (Pl. XVI. figs. 3, 4), and correspond in position to three of the edges of a cube.

Diacts.

The two rays of a diact belong either to the same or to different axes, and may resemble or differ from one another. The two rays usually form together a straight or curved rod. Only very rarely are they disposed at right angles (Pl. LIX. fig. 16).

Many diacts show traces of undeveloped rays in the form of knobs (Pl. V. fig. 7), or as a ring-like thickening (Pl. XXI. figs. 7, 8, 10), or in the presence of two or four canals crossing the main axial canal at right angles. In many cases every trace of their derivation from hexact forms has been lost (Pl LXII. fig. 6). Where only two knots occur on the boundary between the two developed rays, or where two opposite cross canals occur, we have to deal with the derivation of the diact from a tetract form, in which the third axis of the original hexact has been entirely lost.

Many variations occur in the terminal development of the two rays, which are sometimes simply rounded, sometimes pointed, thickened, or knob-like, and often also provided with button or umbel-like structures of the most diverse kind. The two rays may be uniform, or most variably differentiated. They may be smooth or rough, wholly or partly beset with points, prongs, or spines, varying extremely in number, form, size, and direction. The direction of the prongs, with which many diacts are beset all round and throughout their whole length, usually remains the same from one end to the other (Pl. XLV. fig. 6, and Pl. LXXI. fig. 4), but the direction may be reversed on either of the two rays, so that the prongs have their points turned to either end of the diact (Pl. XVI. fig. 12), or, on the other hand, towards the centre (Pl. XL. fig. 5).

The obliquely directed prongs occasionally assume a flat form, like certain leaf buds (Pl. XL. fig. 8), or the scales of the fir cone (Pl. XXXVI. fig. 7).

A very peculiar and typical diact structure, characteristic of the whole family of the Hyalonematidæ, is found in the so-called "*Amphidiscs*," in which a terminal expansion of a disc-like, or spherical form, always curved towards the centre, is borne on the end of each ray. The disc is prolonged into several (six to twelve) tooth or shovel-like marginal protuberances, which in the peculiarities of their length, form, and direction, contribute essentially to the characteristic features of the different genera and species.

Among the asymmetrical diacts some forms occur, which exhibit a certain similarity to the terminal umbels of the *Amphidiscs*. Certain anchor-like forms exhibit curved, hook-like, more or less flat teeth, which suggest the main rays of a pentact; but the anchors exhibit, at the same time, the marginal prongs characteristic of the thickened terminal portion of a diact, which has been pulled out to a great length, and ends in a point or in a simple knob (Pl. III. fig. 29; Pl. XVI. fig. 11). The anchor teeth of such a diact do not, of course, possess any central canal, and the axial cross of the central canal is frequently clearly seen at a considerable distance from the whole terminal thickening of the anchor stalk (Pl. XVI. figs. 11, 13).

I have applied the term "*Uncinata*" to the rod-like forms which run out to a point at both ends, and are provided with barbs pointed in the same direction. For such forms Carter[1] has lately suggested the name "*Barbula*," but this term would not be generally understood. In some species these more or less thickly placed prongs lie close to the body of the rod, while in others they are obliquely directed. They are sometimes delicate and narrow, sometimes broad and scale-like.

Certain Hexactinellidan families have typical and regular *Uncinata*, while in others they are absent. They are usually directed at right angles to the surface, with their external points in the skin (Pl. LXXIV. fig. 1, Pl. LXXXIV. fig. 1); occasionally they lie obliquely to the surface or quite irregularly (Pl. LXXVIII. fig. 2; Pl. XCV. fig. 2).

Among the asymmetrical diacts a form occurs in which one of the two rays bears numerous obliquely and outwardly directed teeth or scales, whilst the other remains smooth (Pl. XXX. fig. 7), or exhibits only small knobs (Pl. XL. fig. 6).

Feeble, irregular, undulating curvature is exhibited especially on the frequently numerous tuft-like, long and filiform diacts (Pl. V. fig. 14). The simple arc-like form occurs, on the other hand, in shorter and stronger diacts (Pl. III. fig. 21; Pl. LXII. fig. 6; Pl. LXIII. fig. 4). A spiral cork-screw-like form is illustrated by the diacts of *Hyalostylus dives*, which are rough on one side (Pl. LXX. figs. 5, 8). More marked curvature of both rays in the same plane is exhibited by small diacts in *Holascus stellatus* (Pl. XIV. fig. 12). In other cases the rays are bent towards each other in a hook-like fashion, but on opposite sides (Pl. XVI. figs. 5–7).

Monacts.

While the derived nature of a monact spicule is in many cases determinable by the presence of rudimentary abortive rays (Pl. LXV. fig. 8), or by the persistent intersection of the corresponding axial canals at one end of the spicule; this becomes difficult when neither rudiments of other rays, nor traces of their axial canals persist. The presence of a knob or disc-like expansion at one end does not of itself determine the monact character of the spicule in question, since, as we have seen in the anchor-shaped diacts, the axial cross of the central canal, which is the decisive character, lies at some distance from the thickened end, and may thus demonstrate the diact character of the simple spicule.

It seems to me, however, that those spicules, called by Carter "*Clavulæ*," which run to a point at one end, and bear a knob or terminal toothed umbel at the other (Pl. LXXI.–LXXV.) as characteristically seen in the genus *Farrea*, are really monacts; although I have, like O. Schmidt, been unable to detect an axial canal in their terminal umbel, or in the swollen portion below. This opinion is, however, the more probable,

[1] *Ann. and Mag. Nat. Hist.*, 1885.

since O. Schmidt has discovered and figured such an axial canal cross, just in the middle of four teeth on the little anchor spicules (of the same genus *Farrea*), which belong to the same system as the " *Clavulæ*."[1]

Though I agree on this point with O. Schmidt, I cannot accept his opinion that the monact umbel and anchor spicules of *Farrea* are homologous with the terminal rays of certain discohexasters to which they have some resemblance. These terminal rays I regard simply as prongs without axial canals; the umbel and anchor spicules, on the other hand, I regard as true monacts.

Mode of Union of the Spicules.

After this general review of the most important forms of spicules, I pass to describe their modes of union. In many Hexactinellida there is no distinct union between the individual spicules, which either lie quite isolated in the soft tissue, or exhibit only a slight connection or mutual support by being closely disposed side by side, or by being interwoven or entangled with each other (Pl. XVII. fig. 6). In other cases, however, numerous spicules are bound into a firm framework by a laminated siliceous substance. It may be that parallel or closely opposed rays become surrounded by a common concentrically layered sheath of siliceous lamellæ and so become united into a beam (Pl. LXXVI. fig. 5; Pl. C. fig. 2), or it may be that the ends of the rays of one spicule are opposed to the intersection nodes of another, and become fixed as if soldered; or further, it may be that the rays of adjoining spicules crossed in any direction are bound together by lamellæ of silex, so laid down that the interspaces are filled by web-like layers of siliceous substance (Pl. XX. fig. 3). Smaller hexacts frequently occur in which the end of one ray is soldered transversely to a larger beam (Pl. XXVII. fig. 8). If there be no immediate contact of the adjoining spicules, then boss or cone-like elevations may grow out from the sides of two opposite beams, meet one another, and, becoming surrounded with laminated siliceous material, form transverse bridges or *Synapticula*,—which have not, of course, axial canals (Pl. XX. figs. 2–4). Finally, in certain conditions, both adjoining spicules, and the branches of one and the same spicule, may become connected by a fine delicate lattice-work, with quadrate or rounded meshes. The beams of the network arise at right angles to the lateral borders of the spicular rays, and always lie in the same plane, while they are further united by transverse anastomoses. Here again there is no axial canal (Pl. LXIV. fig. 3). When this lattice-work is greatly developed, the gaps may be quite filled up, so that finally a thin siliceous plate results. It is remarkable that such lattice-work and plates are found only in bounding surfaces which come into contact with solid bodies, especially where the Sponge has grown on a solid substratum, but also round about foreign bodies which have

[1] Spongien des Meerbusens von Mexiko, ii. p. 38, Taf. v. fig. 9.

penetrated into the Sponge parenchyma, and on the surface of Sponges which are set in cavities of stones or are surrounded by sand and gravel.

Several attempts have been made to utilise for systematic purposes the various modes in which the spicules are more or less united into a framework. Thus, in contrast to the *Coralliospongia*, which possess a firmly united spicular framework, Saville Kent has named the Hexactinellida in which spicules remain disconnected, *Calicispongia*, and Carter has distinguished the following three great groups:—(1) spicules united by silicified fibre; (2) spicules united by amorphous sarcode; (3) spicules united partly by vitrified fibre, and partly by amorphous sarcode.

Marshall, on the other hand, maintains that the free or united condition of the spicules is less significant in the classification of Hexactinellida than the manner in which the union actually occurs. His distinction of Synauloidæ, with open communication between the axial canals of all dictyonalia, and Asynauloidæ, without such a union of the axial canals, did not, however, find acceptance, for it was soon shown that there are no Synauloidæ in this sense. Zittel accepted Marshall's ideas, however, to this extent, that he also based his classification mainly on the nature of the union between the dictyonalia, and distinguished two great divisions, Lyssacina and Dictyonina. The Lyssacina of Zittel embrace, besides forms with disconnected spicules, those in which there is simply a cementing of the spicules, that is to say, such an external union that the spicules do not seem to be checked either in their free arrangement or in their perfect development. In the Dictyonina the spicules of the lattice-framework, the dictyonalia, are, on the other hand, normally fused in such a way that the corresponding rays of neighbouring spicules are closely apposed, and become so completely united by a uniform coating of silex, that their original independence is revealed only in the presence of two separate but closely approximated axial canals. Zittel has also drawn attention to the fact, that Dictyonina frequently possess spicules which are apposed and bound together in more irregular ways; and O. Schmidt has confidently maintained the occurrence of transitional forms between Lyssacina and Dictyonina. He insists that this dictyonal character is manifested by many forms, as, *e.g.*, in his genus *Hertwigia*, in the firmly united inferior portion, while the loose and irregular union of the spicules in the middle, and the entire absence of fusion in upper and outer portions, relates the form to the Lyssacina.

It seems to me indeed difficult to distinguish, in many cases, whether a form belongs to the Lyssacina or Dictyonina. I have, in fact, found forms in which, in a few places, regular fusion was to be observed, while, in other respects, almost all the spicules were cemented together in the irregular way of the Dictyonina. I have, therefore, long endeavoured to find other characters which might serve as sure points of distinction between the two groups, but I have been able to discover only one fact, which might, indeed, justify a separation of the groups, though only at best a distinction of degree,

and incapable of practical application in many cases. While in the Lyssacina the cementing of the spicules occurs at a relatively very late stage, and generally only after the Sponge has attained its final form and size, the continuous framework of the Dictyonina is formed at once in every newly developed portion, and constitutes from the very beginning an important factor.

The spicules of the Lyssacina are, during the entire period of growth, easily separable from one another; but when they become united by the cement into a rigid framework, the growth of the sponge ceases. In the Dictyonina, on the other hand, on account of the early development of the rigid framework, growth can only continue through increase on the surface or at the ends, but there is as little definite limit to this superficial growth as to the general growth of those Lyssacina in which the spicules are never firmly united.

It seems to me worthy of notice that, in certain divisions of the Lyssacina, as, *e.g.*, in the great family of the Hyalonematidæ, and in the subfamily of the Holascinæ, a firm union of the spicules never occurs. It is certainly no accidental fact that it is in these very divisions that the largest species occur, such as *Poliopogon gigas, Poliopogon amadou, Pheronema giganteum, Malacosaccus vastus.*

Position and Arrangement of the Spicules.

The position and arrangement of the spicules now remain to be considered. A definite grouping and naming of the spicules is of obvious advantage for description even in those cases where no sharp distinctions exist between the various categories. I would, therefore, endeavour to complete the classification and nomenclature already adopted by Marshall.

Prostalia.

The more or less prominent spicules which occur over the outer surface of the Sponge I call *prostalia.* They occur only in Lyssacina, and may, from their position, be more intimately defined and differentiated as *basalia, pleuralia,* and *marginalia.*

Basalia.—The basalia are prominent spicules at the lower end of the Sponge, grouped together like bunches of long hairs, and forming the root-tuft which serves for anchoring the animal in the mud. This is one of the characteristic family peculiarities of the Hyalonematidæ, but it also occurs in many Euplectellidæ and some Rossellidæ.

When the knowledge of the Hexactinellida was still limited to a few forms, such as *Euplectella aspergillum, Hyalonema sieboldii,* and some Dictyonina, it was proposed to utilise the presence or absence of a root-tuft as a leading principle of classification, and to erect a special group of "Lophospongiæ." In this, the importance of what is merely an adaption to the nature of the ground, was over estimated. We now know, in fact,

very closely related forms, perhaps even referable to the same genus, one of which occurs on soft ground, and possesses a completely developed root-tuft, while the other, which

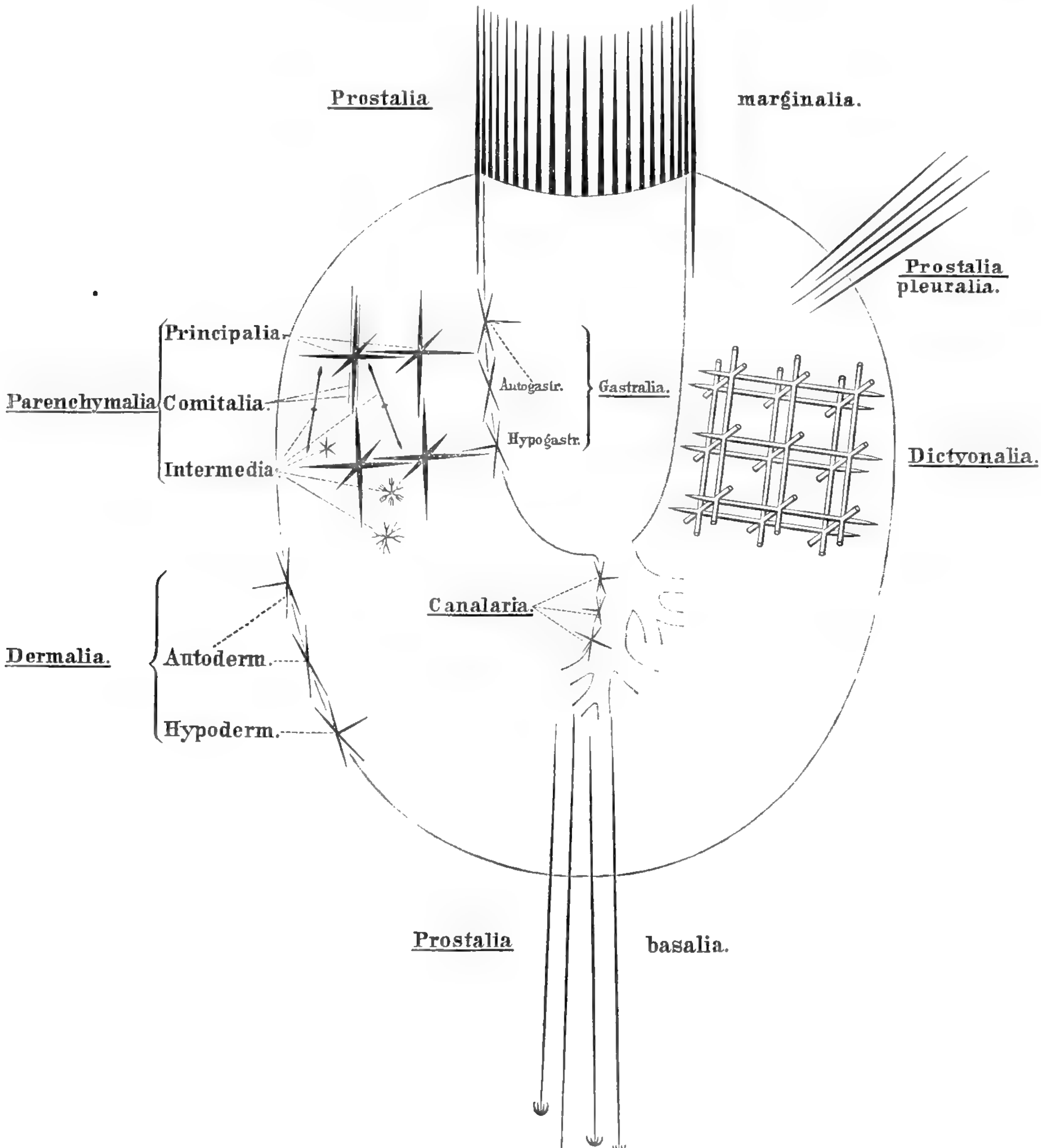

Fig. 2.—Diagram of the arrangement of the Spicules.

grows on a firm substratum, exhibits no trace of such a structure. It is, indeed, readily conceivable that one and the same species might, in different circumstances, produce a root-tuft or not.

The elongated spicules which form the root-tuft are either smooth or beset with barbs, disposed in various ways. While the upper end, which is concealed in the parenchyma, always runs out to a simple point, the free inferior extremity usually bears an anchor-like structure, which varies greatly in form and morphological significance. A knob-like terminal swelling may occur, from the sides of which a few prongs, arranged in a whorl, project obliquely upwards and outwards; or again, four cruciate rays may be present, lying in two typical axes, or rarely two rays in one transverse axis. These rays are bent upwards in hook-like fashion. In the first case we have usually to deal with diacts, in which the axial-canal cross is usually recognisable on the stalk, at some distance above the anchors, while the anchor-teeth do not exhibit any axial canal (Pl. XIV. fig. 5). In the other cases, however, we have to do with pentacts and triacts, in which four cruciate or two curved transverse rays lie in the same plane, with axial canals usually distinctly recognisable (Pl. III. fig. 23, and Pl. LIV. fig. 9).

The arrangement of the barbs on the anchor-stalk, and the form of the anchor-teeth, are often generically characteristic. In many root-tufts besides the anchor-spicules, simple pointed diacts frequently occur.

Pleuralia.—The spicules that project markedly from the lateral walls of the Sponge sometimes exhibit an essential similarity to the basalia, from which they cannot, indeed, be sharply separated even in regard to position. In *Pheronema giganteum*, for instance (Pls. XLV., XLVI.), bundles of long spicules with round swellings are radially distributed, with tolerable regularity, over the whole outer surface; and those directed downwards (basalia) differ from those placed in a more lateral position (pleuralia), only in their greater length, slight curvature, and union in a basal tuft. In the *Polylophus philippinensis* (Pl. LIV. fig. 1) numerous pleural spicules assist in the formation of a local tuft, by bending down and becoming approximated to the basalia. The outermost termination of these pleuralia exhibit the same anchor-structures as are present in the basalia of the same form. Thus, both in pleuralia and basalia, in *Pheronema giganteum*, for instance, two slightly bent hooks, lying in the same transverse axis, occur (Pl. XLV. fig. 9), and in *Polylophus philippinensis* four intersecting transverse rays with a gentle curvature (Pl. LIV. fig. 9).

In other cases the prominent radial pleuralia, which occur either in bundles or isolated, have the form of simple, terminally pointed diacts. This is the case, *e.g.*, in *Acanthascus* (Pl. LVI. fig. 2). In *Euplectella suberea* the long, slightly bent radial rays of the large principal pentacts of the quadrate lattice-work extend radially beyond the side walls (Pl. V. figs. 1, 15). In *Rossella velata*, on the other hand, the external end of the large pentact is that at which the four tangential rays intersect at right angles. All these pentact pleuralia project for nearly equal distances from the surface, and almost touch each other laterally, so that a delicate veil is formed, enveloping the whole Sponge.

The pentact pleuralia of *Rossella antarctica* (Pl. LV. figs. 1, 7, 9) deserve special notice. They arise from small conical elevations and project radially in bundles from the outer surface of the Sponge, while their four tangential rays, which arise transversely to the radials, extend at tolerably equal distances over the surface of the Sponge. The tangential rays, which are provided with small prongs and a uniformly rough cortical layer, do not intersect at right angles, but are so disposed at acute angles that the four together enclose a right angle (Pl. LV. figs. 9, 13). Between these pentacts, which also form a remarkable veil-like structure, other longer simple pointed radially projecting diacts occur.

Marginalia.—In the oscular margin of numerous Lyssacina there is a circle of more or less widely projecting spicules—*marginalia*—which usually consist of elongated diacts, in which the axial canal cross, which is often distinctly recognisable, or even indicated externally by boss-like swellings, usually lies almost in the plane of the outer skin. The projecting distal ray is for the most part thickly beset with outwardly directed prickles and prongs; it is less frequently quite smooth, and usually terminates in a point, though sometimes in a small knob-like thickening (Pl. L. fig. 4). The internal, usually much shorter ray of the diact exhibits in some cases small proximally directed prongs (Pl. XL. fig. 6), but is usually smooth and uniformly pointed. The marginalia include those spicules which project freely in a cuff-like fashion from the margin of the terminal sieve-plate in many Euplectellidæ. These differ from the above chiefly in this, that their four transverse rays are not abortive, but remain more or less long, so that the spicules are not diacts but hexacts. At the oscular aperture of *Tægeria* a peculiar form occurs in which the distal rays are specially long and peculiarly bent (Pl. VII.).

Dermalia.

As to the spicules of the dermal skeleton, which all deserve the title *dermalia*, some belong wholly or at least specially to the outer bounding skin, and have their axial cross and transverse rays within the latter, while others lie for the most part *under* the dermal membrane, with a more or less specially developed proximal ray extending for a variable distance towards the interior, and with the axial cross and transverse rays either lying immediately below the inner side of the dermal membrane, or even somewhat removed towards the interior. Although these two forms of dermalia are not by any means sharply separable from one another, it may be convenient to distinguish them by the special designations *autodermalia* and *hypodermalia*, especially where they occur close to one another.

As examples of autodermalia, which are exclusively confined to the dermal membrane, I may cite the dermal tetracts of *Lanuginella pupa* (Pl. LIII. figs. 4, 5) and

Polylophus philippinensis (Pl. LIV. fig. 2), and also the dermal diacts of *Bathydorus baculifer* (Pl. LIX. fig. 11). A ray projecting towards the exterior is found in the pentact dermal pinuli of all Hyalonematidæ and many Asconematidæ, while a ray extending inwards occurs in the dermal pentacts of *Rossella antarctica* (Pl. LV. figs. 2, 3) and other Rossellidæ. Autodermalia with rays projecting both inwards and outwards from the dermal membrane occur in *Balanites* (Pl. XXIII. figs. 13, 14), *Aulascus* (Pl. XXII. figs. 2, 3), and as amphidiscs in all Hyalonematidæ.

As hypodermalia I would note, in the first place, those sword-like hexacts in the Euplectellidæ, which, with their short distal rays, raise the dermal membrane into small peaks, and are usually surmounted by an attached floricome. Hypodermalia are well illustrated, too, by those strong pentacts which, in many Hexactinellida, lie with their four tangential rays closely under the dermal membrane, and bear a greatly prolonged proximal, penetrating like a strong peg at right angles to the surface, more or less deeply into the subjacent parenchyma. The tendency of these hypodermal pentacts to grow inwards may be recognised where the axis cross occurs in the dermal membrane, from the fact that the tangential rays frequently extend obliquely inwards from their points of intersection, and always lie beneath any other dermalia which may be present (Pl. XXXVI. fig. 1).

To the dermal skeleton I refer finally those spicules which I have noted as clavulæ and scopulæ. These forms are disposed at right angles to the outer surface, have the greater part of their elongated uniaxial body embedded in the parenchyma, usually, however, reaching the skin or even extending beyond it with their broadened terminal portion, which contains the axial cross of the central canal. Here, too, we include those fine raphides which sometimes occur in bundles close to the radial rays of other dermalia (Pl. XCII. fig. 2; Pl. XCIII. fig. 2).

Where the skin is raised above the rest of the parenchyma as an independent plate, the spicules of the dermal skeleton are either confined to this plate without being continued on the outer side of the subjacent parenchyma, *e.g.*, in *Semperella schultzei* (Pl. LII. fig. 3), and in *Hexactinella lata* (Pl. XCV. figs. 1, 2), or they occur not only on the independent skin plate, but also on the outer surface of the parenchyma, which then exhibits a special layer of skin, as in *Euryplegma auriculare* (Pl. CII. fig. 3), and *Myliusia zittelii*.

Gastralia.

Relations similar to the above are exhibited by the gastral skeleton which supports the gastral surface and inner side of many efferent canals, and which, in some cases, appears at the oscular border as a direct, and but slightly altered continuation of the dermal (Pl. XXIII. fig. 14; Pl. LXVIII. fig. 1). The difference between gastralia and dermalia is, however, usually distinct enough (Pl. XXV. fig. 3), and the boundary

between the two is generally sharply defined by the peculiar spicules—marginalia—of the oscular orifice (Pl. XXXVIII. fig. 1).

As in the dermal skeleton, so here, under the more superficial, deeper spicules occur, that is, spicules further removed from the inner bounding surface, and more embedded in the parenchyma. These are strong hexacts or pentacts with their radial rays disposed at right angles to the inner surface, and with the four cruciate transverse rays parallel to the same (Pl. XXII. figs. 2, 5). In harmony with the term hypodermalia, these may be designated *hypogastralia*. I must, however, note that hypogastralia are often wanting where hypodermalia are present, and the same is true of other typical spicules like floricomes, amphidiscs, clavulæ, scopulæ, &c. It may be laid down as a rule that the spicules of the gastral skeleton resemble the dermalia of the same Sponge in general characters, but not in their special development, dimensions, and the like. Thus, for example, the radial axis in one or two rays in the gastralia is frequently well developed, while it is absent in the dermalia, and so hexacts in the gastral membrane are often contrasted with pentacts in the dermal membrane (Pl. LVIII. fig. 2). In other cases the free ray is short and broad in the dermal pinuli, but long and thin in the gastral (Pl. XXV. fig. 3). Where the dermal clavulæ exhibit a knob-like extremity, the corresponding gastralia have long anchor-teeth (Pl. LXXV. fig. 2). Dermal scopulæ with pointed teeth are contrasted with gastral scopulæ with button-like teeth (Pl. LXXVII. fig. 2), and so on.

As the dermalia of the outer skin do not usually pass into the afferent subdermal spaces and canals, so the gastralia do not, as a rule, pass from the inner skin bounding the gastral cavity into the efferent canals (Pl. XXI. fig. 2; Pl. LVI. fig. 2). In not a few Hexactinellida, however, there is a development of peculiar *canalaria*, which lie on the inner surface of the efferent canals, and appear to be a continuation of the gastralia; whether it is that, in the absence of a special continuous gastral skin, the efferent canals open directly with large orifices into the gastral space, and the gastral skeleton simply enters into the efferent passages (Pl. XXXV. fig. 2; Pl. XXXVI. fig. 1), or that a special gastral skin encloses the gastral space with a well-developed gastral skeleton, while the efferent passages are, in addition, provided with similar spicules—canalaria (Pl. XLVI. fig. 1). The canalaria are usually present only in the main stems and large branches of the efferent canal system, but are not continued into the ultimate blind ends (Pl. XXXVIII. fig. 1).

Parenchymalia.

While in the dermal and gastral skeleton there is always a very distinct and typical agreement in the position and arrangement of the spicules, this is not the case everywhere with the parenchymal skeleton. I think, however, that here also certain simple relations may be recognised as original, from which the less regular have been secondarily developed.

On the supposition that the arrangement of the parenchymalia will be least modified where the original form of the Sponge is a thin-walled sac, and the typical six-rayed condition of the spicules most distinctly persist, I will start from such conditions as occur in *Holascus* and *Farrea*. Here the chief supporting framework of the parenchyma is formed of large regular hexacts, which are disposed at right angles or parallel to the bounding surfaces. These forms, which may be termed *directalia*, simply lie in the one case with their corresponding rays apposed to one another (Pl. XVI. fig. 2; Pl. XVII. fig. 2), while in the other they are closely united into a rigid framework (Pl. LXXIII. fig. 2; Pl. LXXVI. fig. 5).

The invariably six-rayed spicules, which are concerned in the formation of the continuous dictyonal-skeleton, and which I call *dictyonalia*, are always distinctly recognisable as such, for even when they have not become connected into a regular cubical meshwork, but only in an irregular manner, they are readily recognised by their axial canals. This is not the case with the spicules indicated as *principalia*, which form the chief supporting framework of the parenchyma in the Lyssacina, for these, like the dictyonalia, do not retain their typical position, and further, by no means always exhibit the six rays, being frequently reduced to pentacts, tetracts, or even indeed to simple diacts. Thus, in *Euplectella aspergillum*, for example, tetracts occur in the formation of the quadrate lattice-work on the inner side (Pl. II. figs. 2, 5), while in *Euplectella suberea* (Pl. V. fig. 15) and in *Euplectella nodosa* (Pl. XIV. fig. 2) pentacts occur for the same purpose and in the same positions; in *Crateromorpha*, *Rhabdocalyptus*, and *Aulochone*, numerous strong diacts are found both in the body and in the stalk.

Closely apposed to the strong rays of the principalia slender elongated spicules frequently occur, with two or three rays, but seldom more (Pl. XVII. fig. 6). These I would call *comitalia*. They are sometimes straight and parallel to the corresponding ray of the principal spicule, but they usually extend in a winding and wave-like manner on or round the outer surface of the principal.

In regard to the position of the parenchymalia, which are found more or less abundantly between the dictyonalia or the principalia and their attendant comitalia, few general points can be noted. While elongated spicules of this category frequently run at right angles to the surface (as the uncinata of many Dictyonina), or are disposed in any other way with complete regularity, very numerous, small, crowded spicules often occur, like the small hexacts, the rosettes and their derivatives, which are almost always scattered quite irregularly in the parenchyma.

NOMENCLATURE AND TECHNICAL EXPRESSIONS.

Dermal membrane.—The external limiting membrane, through the pores of which the water enters the body.

Dermal pores.—The large and small pores which perforate the dermal membrane.

Subdermal trabeculæ.—The delicate strands of tissue which form an irregular framework extending between the dermal membrane and the chamber layer.

Subdermal trabecular space.—The space between the dermal membrane and the chamber layer, and partly traversed by the subdermal trabecular framework.

Chamber layer.—The more or less folded layer of adjacent ciliated chambers.

Connecting membrane.—The continuation of the chamber wall, stretched between the terminal openings of the chambers.

Chamber pores.—The small round apertures in the chamber wall.

Gastral membrane.—The internal limiting membrane directly surrounding the gastral space.

Gastral pores.—The pores of very varied size which perforate the gastral membrane.

Subgastral trabeculæ.—The delicate strands of tissue which are united into an irregular framework, extending between the chamber layer and the gastral membrane, and also frequently into the efferent canals.

Subgastral trabecular space.—The space between the chamber layer and the gastral membrane, which is partly traversed by the subgastral trabecular framework.

Terminal sieve-plate.—A sieve-like perforated plate, which extends over the broad terminal opening of many tubular or cup-shaped Hexactinellida.

Parietal gaps.—Apertures over the whole external wall of the Sponge, through which the space within communicates directly with the surrounding medium.

Membrane of the parietal gaps.—An iris-like, circular membrane stretched across the gaps, with circular bands of muscular fibres, by means of which the orifice may be narrowed or entirely shut.

Covering plate.—A porous plate which surrounds like a capsule the body of some forms with tubular framework, and which is united only to the terminal oscular opening of the tube.

Spiculum.—Every independent and originally isolated skeletal element.

Principal ray.—The primary ray which springs directly from the central nodal point of a spicule.

Terminal ray.—The branch or secondary ray springing from the outer end of a principal.

Hexact, pentact, tetract, triact, diact, monact.—Nouns and adjectives used to designate the spicules according to the number of their principal rays.

Regular hexact.—A hexact with six rays at right angles to one another, of equal length and of similar form.

Oxyhexact.—Hexact with rays running out to a point.

Sphærohexact.—Hexact with spherical terminal knobs.

Discohexact.—Hexact with a transverse disc at the end of each ray.

Rosette or hexaster.—A hexact with equal terminal rays.

Oxyhexaster.—A rosette with straight or bent terminal rays, running out to a point.

Graphiohexaster.—A rosette where the ends of the principal rays bear a bundle of long fine terminal rays in a brush-like manner.

Sphærohexaster.—A rosette with spherical knobs at the ends of the terminal rays.

Discohexaster.—A rosette with transversely disposed, radially symmetrical discs on the outer ends of the terminal rays.

Floricome.—A rosette with S-shaped terminal rays, which are arranged in a whorl like the petals of a lily, and which pass at their outer end into a thickened terminal plate, arched outwards, and provided with external marginal teeth or claws.

Plumicome.—A rosette with numerous S-shaped terminal rays, whose external curved ends form several tiers, one upon another.

Pinulus.—A pentact or hexact in which one ray bears oblique lateral teeth or prickles, presenting a resemblance to a fir tree or fir cone.

Scopula.—A fork-like spicule with a long straight stalk passing at one end into two or more teeth.

Amphidisc.—A diact, at each end of which a convex expansion occurs, which bears six or more backwardly bent marginal teeth.

Ancora.—A rod-like spicule at one end of which two, or several whorled, transverse spikes occur, which are bent backwards like hooks.

Uncinatum.—A straight rod, pointed at both ends, and beset all over with barbs pointing in the same direction.

Clavula.—A rod which bears at one end a club-shaped or transverse discoidal expansion.

Prostalia.—All the larger spicules which project far beyond the outer surface of the body, and which may be readily seen with the naked eye.

Basalia.—The prostalia which project downwards from the lower end of the body, and which form the basal root-tuft by which the Sponge is fixed in the mud.

Pleuralia.—The prostalia which project beyond the outer surface of the lateral portion of the body.

Marginalia.—The prostalia which project in wreath-like arrangement round the oscular margin.

Dermalia.—All the spicules which stand in a definite relation to the external skin.

Autodermalia.—Dermalia which lie either completely, or at least with their axial cross, in the dermal membrane.

Hypodermalia.—Dermalia which lie with their tangential rays more or less closely beneath the dermal membrane.

Gastralia.—All the spicules which stand in a definite relation to the gastral membrane.

Autogastralia.—Gastralia which lie either completely, or at least with their axial cross, in the gastral membrane.

Hypogastralia.—Gastralia which lie with their tangential rays close beneath the gastral membrane.

Canalaria.—Spicules whose axial cross lies in the membrane which lines the efferent canals.

Parenchymalia.—All spicules which are confined to the parenchyma of the soft parts, and which belong neither to the dermal nor to the gastral membrane.

Dictyonalia.—The parenchymalia which become fused to form the continuous skeletal framework of the Dictyonina.

Principalia.—The more or less strong parenchymalia which, in certain circumstances, become fused by siliceous matter, and which constitute the supporting framework of the Lyssacina.

Comitalia.—Thin parenchymalia which are very closely apposed to the principalia.

Intermedia.—Parenchymalia situated between the principalia or dictyonalia.

DESCRIPTION OF GENERA AND SPECIES.

Order **HEXACTINELLIDA,** O. Schmidt, *seu* **TRIAXONIA.**

Sponges with very loose soft tissue, in which the spicules are either isolated or united by a siliceous cement into a connected siliceous skeleton. The spicules belong to the triaxial type, or are readily derivable from it.

Suborder I. LYSSACINA, Zittel (Pls. I.–LXX.; Pl. CII.).

Hexactinellida in which the needles either remain always isolated, or are partly subsequently united in an irregular fashion, often forming strands bound together by siliceous cement, or ladder-like trabeculæ, by means of numerous synapticula.

Tribe I. HEXASTEROPHORA, F. E. Schulze (Pls. I.–XXVI.; Pls. LIII.–LXX.; Pl. CII.).

Hexasters are always found in the parenchyma. The chambers are clearly marked off from one another, and are thimble-shaped.

Family I. Euplectellidæ, Gray (Pls. I.–XX.; Pl. LXX.).

Saccular or tubular Lyssacina, in which the inferior blind extremity is either rooted in the mud by means of a tuft of fibres, or fixed by a compact base on a firm substratum. The relatively thin lateral wall is in some genera perforated by round or irregular apertures or gaps, more or less regularly arranged, while in others it is non-perforated. The transversely truncated or dome-like upper end is generally (everywhere ?) covered by a perforated sieve-plate, and is bordered by a wreath of freely projecting marginal spicules (marginalia), or by a cuff-like fringe. The outer surface of the lateral wall—apart from the gaps—is either uniformly smooth, or exhibits ridge-like elevations; sometimes it is richly furnished with radially projecting spicules. On the inner surface there may be observed—apart again from the gaps—furrow-like grooves in more or less regular arrangement.

The parts of the skeleton are either entirely isolated, or partly united in an irregular

manner into a continuous framework. This fusion is effected by a process of cementing (soldering), or by means of synapticula.

The *dermal skeleton* is formed of sword-like hypodermal hexacts, of which the prolonged proximal rays penetrate the parenchyma at right angles to the surface, while the shorter distal rays raise the outer skin into a conical point, and either bear on their tips a protruding floricome, or are surrounded by several freely projecting pointed diacts. The four tangential rays of the hypodermalia, which stand at right angles to one another, lie just below the sieve-like perforated skin, and form by regular apposition of the corresponding rays a quadrate network.

The gastral skeleton is similarly formed of hypogastral hexacts or pentacts. The prolonged distal ray enters the parenchyma at right angles to the gastral surface, while the opposite proximal ray, when fully developed, raises the gastral skin in an internal point, and also, in some cases, bears on its end a floricome. By the closely apposed tangential rays of the hypodermalia a quadrate lattice-work is formed for the support of the gastral skin.

In the parenchyma of the body, in addition to simple hexacts and their derivatives with a smaller number of rays, numerous rosettes occur, chiefly oxyhexasters and discohexasters.

The chambers, which lie close to one another in a very much folded single layer, have a simple saccular or beehive form. In their thin walls can be seen the elegant quadrate network formed from the anastomoses of the ciliated cells, and here and there a round chamber pore. The delicate trabecular framework, which extends on the one hand between the outer skin and the chamber layer, and on the other, between the latter and the gastral membrane, is abundantly penetrated by the lacunæ and canal-like apertures of the incurrent and excurrent canal system; but besides this, there extends everywhere, between the openings of the chambers, a thin net-like layer, in which numerous oxyhexasters lie embedded.

According to the presence or absence of parietal gaps, I have established two subfamilies, namely, the Euplectellinæ with, and the Holascinæ without gaps.

Subfamily 1. Euplectellinæ (Pls. I.–VI.; Pl. XIII.; Pl. XIV. figs. 1–5).

Euplectellidæ, in which the lateral wall is perforated either by more or less regularly arranged circular gaps, with a membranous margin and circular muscles, or by irregular angular apertures. The sword-like hexacthypodermalia bear a floricome at the end of their distal rays. The hypogastralia are, as a rule, simple pentacts without a proximal ray, but here and there hexacthypogastralia also occur, with a floricome at the end of the principal ray. The central type and best starting-point for the study of this subfamily is the genus *Euplectella*.

Genus 1. *Euplectella*, Owen (Pls. I.–VI.; Pl. XIII. figs. 5–7; Pl. XIV. figs. 1–5).

1841. Owen, Proc. Zool. Soc. Lond., vol. ix. pp. 3–5.
1843. Owen, Trans. Zool. Soc. Lond., vol. iii. (2) pp. 203–206, tab. xiii.
1847. Toulmin-Smith, Ann. and Mag. Nat. Hist., ser. 2, vol. xx. p. 176.
1857. Owen, Trans. Linn. Soc. Lond., vol. xxii. (2) p. 117.
1858. Bowerbank, Phil. Trans., vol. cxlviii. (2) p. 279.
1861. Ehrenberg, Monatsber. d. k. preuss Akad. d. Wiss. Berlin, 1, p. 448.
1862. Bowerbank, Phil. Trans., vol. clii. (2) p. 747.
1864. Bowerbank, Monograph Brit. Spongiadæ, vol. i.
1866. Gray, Ann. and Mag. Nat. Hist., ser. 3, vol. xviii. p. 487.
1867. Bowerbank, Proc. Zool. Soc. Lond., pp. 18, 351.
1867. Gray, Proc. Zool. Soc. Lond., p. 492.
1867. Semper, Archiv f. Naturgesch. vol. xxxiii. 1, p. 84.
1868. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. i. p. 161.
1868. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. ii. p. 373.
1868. Marshall and Herklots, Archives Néerlandaises, iii. p. 435.
1868. Claus, Ueber Euplectella aspergillum.
1869. Moore, Ann. and Mag. Nat. Hist., ser. 4, vol. iii. p. 196.
1869. Bowerbank, Proc. Zool. Soc. Lond., p. 66.
1871. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. viii. p. 330.
1872. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. ix. p. 442; vol. x. p. 134.
1873. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xii. p. 349.
1873. Wyville Thomson, Good Words, July, p. 510.
1874. Th. Higgin, Ann. and Mag. Nat. Hist., ser. 4, vol. xiii. p. 44.
1875. Bowerbank, Proc. Zool. Soc. Lond., p. 272.
1875. Marshall, Zeitschr. f. wiss. Zool., Bd. xxv., Suppl., p. 142.
1876. Willemoes-Suhm, Zeitschr. f. wiss. Zool., Bd. xxvi. p. lxxiii.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii. p. 113.
1877. Wyville Thomson, The Atlantic, p. 138.
1878. Chimmo, Natural History of Euplectella aspergillum.
1879. Moseley, Notes by a Naturalist on the Challenger.
1879. Agassiz, Bull. Mus. Comp. Zool., vol. v.
1880. O. Schmidt, Spongien des Meerbusens von Mexico, vol. ii. p. 60.
1880. F. E. Schulze, Trans. Roy. Soc. Edin., vol. xxix. (2) p. 661.
1881. Witefield, Amer. Journ. Sci. and Arts, July and August.
1881. Milne-Edwards, Comptes rendus, t. xciii. pp. 876, 931.
1881. Walcott, Amer. Journ. Sci. and Arts, vol. xxii. pp. 394, 395.
1885. Filhol, La vie au fond des mers, p. 282.

History.—After a preliminary communication which appeared in 1841,[1] Owen published in 1843 the first accurate description of *Euplectella aspergillum.*[2] In this somewhat brief, but precise and clear description of a well-preserved skeleton from the Philippines, the structure, as seen by the naked eye, or under the magnifying power of a simple lens, is so thoroughly investigated that later observers have had but little to add to it.

As the most essential difference between his *Euplectella aspergillum* and the *Alcyoncellum speciosum*, Quoy and Gaimard, Owen emphasises the fact that in *Euplectella*

[1] *Proc. Zool. Soc. Lond.*, vol. ix. pp. 3–5.
[2] *Trans. Zool. Soc. Lond.*, vol. iii. pp. 203–205, pl. xiii., 1843.

a transverse, slightly convex sieve-plate closes that end which he regarded as the inferior, while *Alcyoncellum speciosum* appeared to exhibit a simple inferior extremity. Further, as he had inadvertently read the word *Alcyoncellum Alcyonellum*, he maintained that, even if there was a generic agreement between his Sponge and that described by the French investigators, yet the name *Alcyonellum* must be changed since it had been already bestowed by Lamarck on a Bryozoon. Owen also erred in regarding *Alcyonellum gelatinosum*, Blainville, as synonymous with *Alcyoncellum speciosum*, Quoy and Gaimard.

In a paper which appeared in 1857,[1] Owen described a second species of the same genus under the title *Euplectella cucumer*. This he distinguished from *Euplectella aspergillum* by its barrel-like form, by the absence of the oblique ridge and of the cuff-like collar at the extremity, which in this species is truncated and closed by a sieve-plate. The single specimen upon which the description was based was presented to Captain Etheridge by the King of the Seychelles.

The generic characters of *Euplectella*, which were more definitely formulated in this than in the previous memoir, are as follows:—"A cylindroid hollow form of body, closed at the wider end by an irregular network, and at the narrow end by the terminal tuft of finer filaments into which the parietal fibres are there resolved. The parietal fibres, or those that constitute the wall of the cylinder, are regularly disposed, and intersect each other at definite and nearly equal distances throughout its extent. They consist of longitudinal, transverse, and oblique fibres, the latter being of two kinds, winding spirally round the cylinder, but in opposite directions. The longitudinal and transverse fibres are the thickest; they are arranged at intervals of from one to two lines, averaging one line and a half apart, and divide the cylinder wall into square spaces of about the latter diameter. The longitudinal fibres are external to the transverse ones, to which they are bound by the oblique or spiral fibres; these are, some external, some internal, to the others, and they close by their decussation alternate quadrate intervals between the longitudinal and transverse fibres. The angles of the alternate open squares are intersected by finer and less regular oblique fibres, which reduce their area more or less to a circular form."

The fact that, in the specimens on which the description of *Euplectella cucumer* was based, the tuft of long siliceous spicules included a number of foreign bodies, led Owen to believe that the fixing of this sponge, and also of *Euplectella aspergillum*, was not effected by means of a sieve-plate, but by the long hair-like tuft; and accordingly, that the natural position was the inverse of what he had formerly described in regard to *Euplectella aspergillum*.

A treatise by Bowerbank, which appeared in 1858,[2] contained a detailed description of sponge spicules. In this memoir several of the beautiful microscopical spicules which

[1] *Trans. Linn. Soc. Lond.*, vol. xxii. (2), pp. 117–124, pl. xxi.

[2] On the Anatomy and Physiology of the Spongiadæ, *Phil. Trans.*, vol. cxlviii. p. 279, pls. xxii.–xxvi.

lie scattered in the soft tissues of *Euplectella aspergillum* and *Euplectella cucumer* are described and figured.

In Max Schultze's well-known research, "Ueber Hyalonema," published in 1860, there are also some observations on *Euplectella* spicules. It is interesting to note that Schultze regarded *Alcyoncellum speciosum*, Quoy and Gaimard, as identical with *Euplectella aspergillum*, Owen. The same view was held by Bowerbank, who in 1862, in his third communication On the Anatomy and Physiology of the Spongiadæ,[1] regarded it as indisputable that the older generic name *Alcyoncellum* of Quoy and Gaimard should replace the name of *Euplectella* given by Owen. He himself, however, inconsistently employed not the specific designation *speciosum* but *aspergillum*. Instead of adopting the generic diagnosis proposed by the French authors, Bowerbank preferred the following summary of the characters of the genus *Alcyoncellum*:—"Sponge fistulate; fistula single, elongate, without a massive base. Skeleton: primary fasciculi radiating from the base in parallel, straight, or slightly spiral lines; secondary fasciculi at right angles to the primary ones. Oscula congregated, with or without a marginal boundary to their area."

In his British Spongiadæ (1865), Bowerbank figured and described different parts of the skeleton of *Alcyoncellum aspergillum*, *Alcyoncellum corbicula*, and a new but not minutely described species, *Alcyoncellum robustum*, Bowerbank (strictly *Alcyoncellum robusta*).[2]

In a short historico-critical paper on Venus' Flower Basket, published in 1868, Gray maintained the identity of *Alcyoncellum speciosum*, Quoy and Gaimard, and *Euplectella aspergillum*, Owen.[3] Since the designation *Alcyoncellum* was first employed as a generic name for a calcareous Sponge (*Alcyoncellum gelatinosum*, Blainville) by Blainville, Owen's generic name *Euplectella* might be preferred; but the original specific designation *speciosa* of Quoy and Gaimard should be restored, so that this beautiful siliceous Sponge should in future be called *Euplectella speciosa*, Quoy and Gaimard.

In the following year, 1867, Gray described the structure of the skeleton of a young specimen of the same species.[4] He refers the bent form of the tubes to the presence of Crustacea which appear constantly in the interior. *Euplectella cucumer*, Owen, is not regarded as a distinct species, but only as a form-variety of *Euplectella aspergillum*, Owen.

During his stay in the Philippines Semper had opportunity of examining numerous specimens of *Euplectella aspergillum*. He questioned the identity of *Alcyoncellum speciosum*, Quoy and Gaimard, and *Euplectella aspergillum*, Owen, and wished to

[1] *Phil. Trans.*, vol. clii. p. 1103.
[2] *Loc. cit.*, figs. 257, 258.
[3] *Ann. and Mag. Nat. Hist.*, ser. 3, vol. xviii. p. 487–490.
[4] *Ann. and Mag. Nat. Hist.*, ser. 3, vol. xix. pp. 44, 138.

restore the latter designation.[1] The crustacea that constantly occur in the large lumen of the tube, Semper identified as a Palæmonid, along with which there frequently occurs an isolated *Aega*, named by him *Aega spongiophila*.

In the same year (1867), in his attempt to form a general system of the sponges,[2] Gray erected an order of "Acanthospongiæ" in which "spicules of more than one form or kind" appear "in the same sponge," and to this he referred, among others, a special family of the Euplectellidæ with the following characteristics:—"Sponge tubular, skeleton composed of longitudinal, transverse, and oblique bundles of spicules, intersecting each other and forming a network. Sarcode mucilaginous, studded with many rayed stellate spicules." To this family Gray also referred, in addition to the genus *Euplectella*, two other new genera, *Corbitella* and *Heterotella*, which differ from *Euplectella* chiefly in the absence of the regular longitudinal and circular disposition of the fibrous skeletal strands. The diagnosis of the genus *Euplectella* is given by Gray[3] as follows:—"The tubes regular, gradually wider above, formed of regular longitudinal and transverse bundles of filiform spicules, which are crossed in an oblique direction with more slender fascicles or separate filiform spicules, and strengthened externally with transverse or obliquely raised ridges; the upper ridge forming a fringe at the top of the tubes, between the edge of the tubes and the irregularly netted lid. Sarcode thin, studded with many rayed stellate spicules, with long simple or trifid rays, or with short rays divided at the end into several converging rays, forming a bell-shaped series."

As specific examples *Euplectella aspergillum*, Owen, and *Euplectella cucumer*, Owen, are cited.

In 1868, Claus published a detailed research on the architecture, formation and structure of the skeleton of *Euplectella aspergillum*, Owen.[4] The different forms of spicules are intimately described, and the fusion of certain groups by the deposition of siliceous lamellæ is demonstrated.

In Bowerbank's critique on Gray's arrangement of the Sponges,[5] the separation of the family of the Euplectellidæ from the "siliceo-fibrous sponges" is censured, since their skeleton is "truly siliceo-fibrous."

A new Japanese species belonging to the genus *Euplectella* has been described by Herklots and Marshall,[6] under the name of *Euplectella oweni*. It is characterised both by its saccular form, which gradually diminishes upwards, and by a peculiar arrangement of the round parietal pores, with which variations in the skeletal structure are associated. In this species there is no cementing of the long siliceous spicules into longitudinal fibrous strands, and in place of the outwardly directed oblique ridges there are downy siliceous hairs covering the surface.

[1] *Archiv f. Naturgesch.*, vol. i. pp. 84–89, 1867.
[2] *Proc. Zool. Soc. Lond.*, pp. 492–558.
[3] *Loc. cit.*, p. 528.
[4] Ueber Euplectella aspergillum, p. 4, 1868.
[5] *Proc. Zool. Soc. Lond.*, p. 118, 1868.
[6] *Archives néerland Sc. exact. et natur.*, vol. iii. p. 458.

In an article on *Semperella* (*Hyalonema*) *schultzii* (1869), Gray also expressed an opinion on the relation of *Euplectella cucumer*, Owen, and *Euplectella aspergillum*.[1] He said :—"The different shape of the body of *Euplectella aspergillum* and of *Euplectella cucumer* may indicate that they grow in different situations and circumstances. *Euplectella cucumer* most probably grows in the mud, kept in its place by a mooring of stones, as figured in Professor Owen's plate. The curved form of *Euplectella aspergillum* would lead one to believe that it most probably grows on the side of a perpendicular rock, but I have no proof that this is the case, except the form. If it grew from a horizontal surface, the top of the tube or cloaca would not be uppermost, and the *Euplectella* would not be in the upright position natural to all Sponges and other animals and plants that live on the bottom of the sea."

With regard to the habitat of *Euplectella aspergillum*, Owen, a communication published in the same year, 1869, by Thomas J. Moore,[2] is of interest. He communicates the account given by a certain Captain Morgan, who observed at Zebu (which is at a distance of three nautical miles from the village of Talisay), the capturing of "Regadera" by the natives. On the two extremities of the transverse beam of a large T-shaped iron apparatus, a long bamboo rod with numerous iron hooks is fixed horizontally on each side. This apparatus is let down upon the muddy ground at a depth of 130 or 135 fathoms, and is dragged over the bottom by the boat, which is carried along by the ebbing tide, until the fisherman observes that something has been caught. On pulling it up, some Regaderas are usually found to have been caught by the hooks. These are at first dirty and of a yellow colour, but after maceration in fresh water they acquire a beautiful appearance. The root tuft of the Sponge remained in the soft muddy or sandy bottom, while the entire upper tubular portion of the body projected freely, and its truncated terminal surface "turned itself towards the setting sun." Another verbal communication made by Captain Morgan to Moore is also noteworthy, since, according to it, the natives only capture the Regadera when the boat is carried onwards in a given direction, but never when it moves in the opposite course.

In the change which Gray[3] proposed in 1872 upon his above-mentioned Sponge System of 1867, he placed within the order Coralliospongiæ, and in that section which possesses "hexradiate spines in the sarcode," the family of the Euplectellidæ, including the single genus *Euplectella*, and he referred them to that subdivision in which "the sponge is free, attached to the mud by numerous elongated filamentous spicules surrounding its base," and has "small recurved spines at the end"; the "skeleton being formed of elongated spicules more or less united by siliceous secretion."

The family, and at the same time the somewhat altered generic characters, are now stated as follows :—"Sponge tubular, free, formed of bundles of elongated thread-like

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ii. p. 377.
[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. iii. p. 196.
[3] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ix. pp. 442–461.

spicules placed in horizontal, transverse, and oblique directions, often crossing each other, forming a more or less irregular network, and often closed at the top by a netted lid formed of shorter spicules; the base with elongated free spicules terminating in three or four short spines, by which it is fixed to the mud. The sarcode mucilaginous, studded with differently shaped spines, some of which are many rayed, stellate, with clavate arms."

In the system which Carter proposed[1] in 1873 for the Hexactinellida he did not class together the well-known forms hitherto united in the family of the Euplectellidæ, but referred *Euplectella aspergillum* to one of his three chief divisions, where the "spicules" were "held together by silicified fibre"; the genus *Habrodictyon*, Wyville Thomson, he relegated to the group whose "spicules" were "held together by amorphous sarcode"; while for Owen's *Euplectella cucumer*, whose spicules are only united in the lower portion of the sponge by being cemented with siliceous matter into a rigid framework, while they remain isolated above, he instituted, because of this character, a special third division.

As characteristic of *Euplectella aspergillum*, he noted that the body was "tubular, unbranched, and closed at the extremity." This specific character, however, applies equally well to *Euplectella cucumer*, Owen, and to *Habrodictyon*, Wyville Thomson. The two species of the latter, *Habrodictyon speciosum* and *Habrodictyon corbicula*, although separated by Wyville Thomson, Carter thought it necessary to unite in one species, *Habrodictyon* or *Alcyoncellum speciosum*.

In 1874, Higgin[2] described the skeletal structure of a specimen of *Euplectella aspergillum* preserved in the Liverpool Free Museum, which had already, on an earlier occasion, been inspected by Wyville Thomson during his stay in Liverpool, and was referred to in a letter from the Challenger in Good Words, July 1873, p. 510. That communication by Wyville Thomson ran as follows:—"Several samples of *Euplectella* very closely allied to the Philippine species, if not identical with it, came up in the trawl off Cape St. Vincent, and gave us an opportunity for the first time of seeing this Sponge alive. Dr. J. E. Gray writes to the Annals and Magazine of Natural History that specimens have been received of *Euplectella aspergillum* in spirit, and that in these the glassy framework is entirely masked by a soft brown corky coating of sarcode. Our fresh specimens entirely bear out Dr. Gray's description. It would be difficult to imagine that the thick, somewhat clumsy, brown tube, perforated with irregular openings, contained any arrangement of support so delicate and symmetrical."

"Although the forms of all the spicules, down to the most minute and complicated, are identical, the wall of the tube in the European specimens of *Euplectella* is not coherent as in most of the Philippine examples. The original spicules of the skeleton remain separate from one another, and do not become soldered together. One would think that this would be at all events a perfect specific distinction, but one or two of the

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 349. [2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xiii. pp. 44–48.

specimens of *Euplectella aspergillum*, particularly one in the Museum of Liverpool, are in this condition, and I am not yet prepared to say whether all may not be thus soft at a particular stage of growth."

Higgin found that a rigid, firmly united, siliceous framework was only present on the under portion of the sponge, while the upper part appeared quite pliable. In the inferior portion the skeletal spicules were provided with a siliceous sheath, and were firmly connected by means of this; above, on the other hand, this union of the spicules was entirely absent.

According to Higgin, large four-rayed spicules form a fundamental quadrate network. The arms of these spicules lie in exactly longitudinal and transverse directions, and are apposed to one another. The arms of the cross spicules, which are about 2 cm. long, stretch across three or four meshes, and the longitudinally directed arms are still longer. Close to the four-rayed spicules (and united with their arms in a bundle-like manner), are simple, long, rod-like needles with thorny ends. The long arms of the three-rayed, and less frequently also of the four- or six-rayed spicules, are employed in the formation of the oblique fibrous bands. In these spicules two approximately equal arms extend in one straight direction, while the third, or the remaining two or four arise transversely, either straight and at right angles, or slightly bent. The spindle-like swollen extremities of the arms are thickly covered with fine spines. In the description of the simple spicules Higgin does not add anything to the researches of Claus and Carter, but corroborates the opinion already expressed by Semper, that the entire skeleton of *Euplectella aspergillum* always consists in the young state of isolated spicules, which, only at a later stage, become partially fused, and more or less firmly united by the deposition of layers of siliceous substance. This process of fusion begins in the inferior portion of the lattice-like tube.

A communication by Bowerbank[1] gives a more minute account of the arrangement of the loose spicules in the tissue of *Euplectella aspergillum*. There is here to be noted an important advance in our knowledge of the dermal skeleton. Bowerbank first recognised that, for the support of the dermal layer, the whole surface is provided with a system of radially directed, floret-like, six-rayed spicules, and that each of the centrally directed longest rays of these is apposed to a more deeply seated six-rayed spicule, while the four lateral rays are applied to the corresponding lateral rays of the four adjoining spicules of similar formation, and thus form a regular network of approximately equal quadrate meshes, while the distal ray, which is of about the same length as the lateral rays, projects radially outwards. Each of these freely projecting, radial, distal rays, bears terminally one of these elegant structures which are designated by Bowerbank "floricomo-hexradiate spicules." These appear in no other region of the soft body of this sponge, and are regarded as protective weapons against small worms, &c. The quadrate meshes

[1] *Proc. Zool. Soc. Lond.*, p. 503, 1875.

of the skin skeleton are said to be completely closed by a thin transparent membrane, and in the latter, groups of small "quadrifurcate hexradiate spicules" occasionally occur. In the interior of the soft body Bowerbank thought he could perceive numerous "gemmulæ" surrounded by a simple membrane.

In Marshall's research on the Hexactinellida, published in 1875,[1] there is a detailed account of the *Euplectella oweni*, Marshall and Herklots, from Japan, which had been already shortly described by Marshall and Herklots. This species is accurately compared with the Philippine *Euplectella aspergillum*, which Marshall had also the opportunity of studying in a young specimen, with as yet entirely unfused spicules.

While there is a great general resemblance in the forms and position of the spicules, as is particularly obvious in comparing *Euplectella oweni* with *Euplectella aspergillum*, there never occurs that fusion of the main spicular bands which occurs in *Euplectella aspergillum* when it becomes old, and which leads to the formation of the elegant lattice-like framework. While, moreover, *Euplectella aspergillum*, which is always much bent, presents an approximately round tube, continually increasing in diameter from the base to the free extremity, and is provided laterally with ridge-like, oblique, outwardly directed elevations, and at the extremity with a cuff, bounding the terminal sieve-plate, *Euplectella oweni* consists of a perfectly straight tube which is oval in transverse section, and without external ridges or a terminal circular cuff. From the broadest part of the tube, which is situated about the boundary between the inferior and middle third, the diameter diminishes very gradually upwards. The closure is effected by a sieve-plate which is somewhat strongly arched outwards.

Sir C. Wyville Thomson[2] published in 1877, a short description of a new species of *Euplectella* (*Euplectella suberea*, Wyville Thomson), of which three more or less injured specimens, figured in a woodcut (*loc. cit.* p. 29), were collected to the west of Gibraltar. It may be well here to repeat the words of the highly respected leader of the expedition :—"The fine species for which I propose the name *Euplectella suberea*, of which three specimens, all unfortunately more or less injured, were taken in the trawl, forms a hollow cylinder about 25 cm. in length by 5 cm. in diameter. The walls are composed, as in *Euplectella aspergillum*, of a fundamental, square meshed, siliceous network, bands of spicules running longitudinally from end to end of the sponge, and transverse bands intersecting these at right angles. The spicules are in some cases straight and smooth, frequently four projecting knobs ranged round the centre of the shaft of the spicule show that, in essential form, the spicule is six-rayed, and often one of the side rays is strongly developed and projects to a distance of half an inch or more from the surface of the sponge. The spicules are all free from one another, and those composing the bands can easily be teased asunder with a pair of needles. In this species, as in *Euplectella aspergillum*, the corners of the square meshes are filled up, a pale brown

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxv. Suppl., p. 142.
[2] The Atlantic, vol. i. pp. 138–140.

corky-looking substance reducing them to round tube-like holes and rising into spirally arranged ridges between them; but the ridges, instead of having a continuous glassy skeleton, have their soft substance supported by a multitude of delicate six-rayed separate spicules interspersed with the usual minute siliceous stars and rosettes. The sponge is hirsute, with sheaves of feathered spicules which project from the crests of the spiral ridges, and a series of like sheaves of great length replace round the mouth the fretted frill of the Philippine Islands form. The mouth is closed by a very delicate network of a gelatinous substance supported by sheaves of fine needles. The correspondence in form between its ultimate spicules and those of *Euplectella aspergillum* appeared to be so close, that when I first saw this sponge I suspected that it might turn out to be the same thing under different conditions. I am now, however, convinced that the two species are entirely distinct." Of importance, too, is Sir Wyville Thomson's further observation:—" No commensal Crustacean has been found in any of the Atlantic specimens of *Euplectella*."

On *Euplectella aspergillum*, Dr. v. Willemoes-Suhm[1] also made some notes during the Challenger Expedition. He writes:—" A single specimen of the water-pot-like sponge was first accidentally dredged seventy years ago, and this, about thirty years ago (1841) fell into the hands of Owen. High offers for further specimens were then made and the second was purchased at a high price. Eight or ten years ago they were still dear, when suddenly the fishermen, induced by this circumstance, discovered in the immediate vicinity of the city of Zebu, a place from which they captured *Euplectella* in abundance by means of an apparatus, constructed of bamboo rods and provided with hooks, which was pulled along the sea bottom. The sponge lives at this place at a depth of 100 fathoms in blackish mud. During our stay in Zebu the ship proceeded one day to the place in question for the purpose of procuring specimens. A bamboo apparatus from a fishing boat and a small dredge from the ship were simultaneously lowered. While, however, the former procured an abundant supply, we got nothing, and only the force of one of the large dredges was sufficient to tear up the sponges, which were evidently in great numbers, but very firmly implanted in the mud." A detailed account of the capture of *Euplectella aspergillum* by the fishermen of Zebu, and of the apparatus used for the purpose, has been given by Chimmo in a paper[2] which appeared independently, and is accompanied by a plate.

With Chimmo's account, the report given by Moseley[3] of the method and apparatus of capture employed by the fishermen of Zebu, entirely coincides.

Agassiz[4] mentions a specimen of *Euplectella* from the collection of Sponges made by the expedition in the Carribean Sea. It is probably the same specimen which Oscar Schmidt[5]

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxvi. p. lxxiii.
[2] Natural History of Euplectella aspergillum, 1878.
[3] Notes by a Naturalist on the Challenger, 1879.
[4] *Bull. Mus. Comp. Zoöl.*, vol. v., 1879.
[5] Spongien des Meerbusens von Mexico, p. 60.

described in the following year (1880), as having been dredged at St. Lucia in 423 fathoms, and at Granada in 416 fathoms, and which he named *Euplectella jovis*. This species is closely allied to Wyville Thomson's *Euplectella suberea*, but differs from it in its large prickles, which project freely outwards, and which, to the number of four or five, form a ring round each of the circular parietal pores. It differs further in the possession of a remarkable spicule with a fibula-like double hook. O. Schmidt also describes a transversely expanded inferior sieve-plate at the lower end of the tube, which differs from the superior terminal plate only in being less firm.

To the Euplectellidæ O. Schmidt also refers his *Regadrella phœnix*, *Hertwigia falcifera*, and *Rhabdopectella tintinnus*. In all three the inferior extremity does not, as in the genus *Euplectella*, run out into a basal tuft, but presents a tolerably firm basal portion, which either consists, as in *Regadrella*, of a dense mass growing out into knobs and lobes, or, as in *Hertwigia*, of irregularly branched protuberances, or finally, as in *Rhabdopectella*, of a simple stalk with a disc-like terminal plate, which is frilled at the margin.

While the siliceous spicules of *Regadrella phœnix* do not differ essentially in form from those of *Euplectella aspergillum*, the general shape and the entire architecture of the sponge is quite distinct. From the massive base a cup arises which is composed at first of a much perforated plate, and further upwards of a flexible lattice-like network of obliquely intersecting beams with round meshes. On the irregularly shaped upper margin of the cup a spicular wreath projects like a cuff. The terminal aperture is, as in *Euplectella*, closed by a sieve-plate. It is remarkable that within the cup of older dead specimens younger forms had settled, so that two, or sometimes even three, individuals appeared as if fixed into one another.

On the branched basis of *Hertwigia falcifera* is seated an "irregular labyrinth of cavities with thin membranous walls, which are supported by lattice-like plates of obliquely crossed rods and fibres." On account of the deficient preservation of the obviously very brittle upper portion, Oscar Schmidt was not able to obtain any definite idea of the form of the entire sponge. Among the siliceous spicules which lie scattered in the soft parts, there are, besides six- to three-rayed spicules and the typical *Euplectella* floricomes, remarkable hexradiate rosettes with four-toothed terminal umbels attached to the individual arms of the rays, and also rosettes with long backwardly bent teeth on the terminal umbels, and especially the structures called by O. Schmidt "sickle rosettes," in which each of the six principal rays bears either four simple sickle-like teeth, or a hemispherical terminal disc with several whorls of sickle-like teeth. Rods occur here and there with numerous oblique lateral prongs at one end. O. Schmidt mentions also, delicate siliceous nets on whose exceedingly fine filaments small terminal hooks and terminal umbels are found, but these nets seem to me to be fragments of Radiolaria.

The stalk of *Rhabdopectella tintinnus*, in older specimens, expands towards its upper

end into a very irregular network with large meshes, so that a labyrinth of hollow spaces is formed. Among the isolated siliceous spicules, in addition to the well-known *Euplectella*-floricomes, the branches of whose rays have a very fine basal portion and an unbent plate with a toothed margin at the extremity, O. Schmidt found rosettes with fine hook-like teeth, or with terminal umbels bearing four or more prongs, and other forms in which each of the six principal rays runs out into five teeth which bear on their extremities hemispherical discs with numerous strong, recurved, marginal rays. Of these five teeth with their terminal discs, the middle one is always distinctly smaller than the four surrounding it. A remarkable spiral bow-shaped spicule with transverse furrows is also mentioned by O. Schmidt, and finally the presence of many rayed stars is noted.

A small sponge with similar siliceous parts, but consisting merely of a simple tube open above, with a loose stalk, and a basal plate which resolves itself at the margin into spicules and spicular bundles, is described by O. Schmidt as a young *Rhabdopectella tintinnus*, and he has accordingly conjectured that the larger (older) specimens are only the upper portions of similar tubes which had been lost in the dredge.

The first reports of fossil Euplectellidæ have been made during the last few years. R. P. Witefield[1] first drew attention to the fact that the structures which were described from the Chemung group of New York, the Waverley beds of Ohio and of several other places, under the name of Dictyophyton, and which were mentioned in the Sixteenth Report of the State Cabinet of Natural History of New York, p. 84, as "algæ of a peculiar form and mode of growth," present a certain resemblance to Euplectellid skeletons, since in the wall of the tube longitudinal and transverse bands of fibres are seen to be united into a network with rectangular meshes. Soon after, Witefield[2] confirmed this view in greater detail, and supported it by reference to a *Uphantænia dawsoni*, which had been described by T. W. Dawson, pointing out that the beams of the rectangular network consist of "fascicles of slender cylindrical rods or spicules, quite cylindrical and smooth," and that the "spaces between the bands and threads are covered by a thin fibre, which is alternately elevated or depressed in the adjoining spaces."

By this communication of Witefield, Walcott[3] was induced after closer examination to announce, as a fossil Euplectellid, an organism which he had formerly described, under the name of *Cyathophycus*, as a fossil Alga, of a tube-like form, and with an enveloping coat of retiform structure. He described "horizontal and perpendicular series of narrow bands crossing each other at right angles, so as to form a network with rectangular interspaces, the narrow bands being formed of thread-like *spicula* resting on or one against the other." Of the form described as *Cyathophycus*, Walcott said:—"The striking resemblance to *Euplectella* is seen at a glance, although the convex summit of

[1] *Amer. Journ. Sci. and Arts*, July 1881; *Ann. and Mag. Nat. Hist.*, ser. 5, vol. viii. p. 167.
[2] *Amer. Journ. Sci. and Arts*, August 1881; *Ann. and Mag. Nat. Hist.*, ser. 5, vol viii. p. 237.
[3] *Amer. Journ. Sci. and Arts*, 1881, vol. xxii. p. 394, 395.

the latter genus is absent, and the margin curves over and downward on the inside to a considerable distance at least, how far is yet unknown." Moreover, he erects a species with the name *Cyathophycus subsphæricus*, and adds that "each species preserves the rounded rim of the circular aperture at the summit."

Character of the Genus.—The more or less regularly disposed circular parietal gaps are surrounded by a soft membrane provided with circular muscle fibres. The tubular or slightly swollen body runs out into a tuft of siliceous fibres at the narrowed inferior extremity, while the upper, transversely truncated end is closed by a flat or outwardly convex sieve, and bounded by a thickened border, which is continued into a wreath of spicules, or into a cuff-like fringe. The larger parenchyma spicules have in the later age a tendency to fuse together, and in adult specimens may unite to form a continuous framework.

The groundwork of the whole skeleton is a system of intersecting longitudinal and circular siliceous strands, which consist of the prolonged rays of strong hexacts, pentacts, or tetracts, and of the apposed thread-like, thin, comital tetracts, triacts, and diacts. The intersections of the fibrous strands form quadrate meshes. The rosettes scattered in the parenchyma are oxyhexasters. The terminal plates of the typical protuberant floricomes have from six to eight teeth.

1. *Euplectella aspergillum*, R. Owen (Pls. I.–IV.).

In general form *Euplectella aspergillum* resembles a thin-walled tube of approximately circular section; the somewhat narrowed lower end is continued downwards into a bundle of longitudinally directed or slightly diverging siliceous fibres, while the superior transversely truncated extremity is closed by a watch-glass-shaped, outwardly convex sieve-plate. In its upper two-thirds the tube is straight or only slightly bent, while the inferior third usually exhibits a more marked, often almost semicircular curvature (Pl. I. figs. 1, 2). If there are two curves, they usually lie in the same plane, but run in opposite directions, so that a form resembling a slightly bent, S-shaped cornucopia results. The length of the full-grown specimens, exclusive of the root-tuft, which measures from 4 to 8 cm., is on an average 24 cm.; the breadth, in the upper portion, varies from 4 to 5 cm.; the lower portion, just above the basal tuft, measures from 2·5 to 3 cm. The dimensions of the individual specimens vary, however, very considerably.

The whole wall of the tube is perforated by numerous parietal gaps, circular apertures of tolerably regular form, and varying from 1 to 2 mm. in diameter. These gaps lie at the bottom of furrow-like grooves, and each gap is surrounded by a stretched, soft, iris-like, circular membrane, provided with a circular muscle. The arrangement of the parietal pores is such, that two intersecting systems of parallel right and left-handed spirals, ascending at an angle of 45°, may be readily recognised. This regularity,

however, is here and there disturbed by the interpolation of separate gaps, and it ceases immediately beneath the superior cuff, in the formation of a perfectly circular row.

The distance between two adjoining parietal apertures in the same row is, in the upper portions of fully-developed specimens, about 4 mm.; at the lower end, on the other hand, and in young forms the distance is only 3 mm. or less. In young specimens, and on the inferior portions of older forms, a slightly arched protuberance is formed in the middle of every four adjacent gaps. By the fusion of the elevations which lie between two adjacent spiral rows, raised bands are formed, which, by further increase, become prominent ledges or ridges. The arrangement and development of these ridges vary greatly on the walls of the lower part of the tube, they are always but feebly developed, but they gradually increase in height towards the upper end. In some specimens they hardly attain a height of 2 or 3 mm.; in other cases, however, they rise to a height of 10 mm. or more. Though they run, for the most part, parallel to the spiral rows of gaps, they seldom continue in the same direction, beyond a semirevolution. They often bend round at right angles, just at the end of half a spiral turn, and extend in the opposite direction down the other side of the tube. Sometimes again they assume an angular or undulating course, and here and there they may even form a meshwork. In specimens bent in an S-like curve, I usually observed several parallel ridges extending in an ascending spiral on both sides, from the lower concavity of the tube to the upper concavity on the opposite side (Pl. I. fig. 1).

Among the ridge-like formations must also be ranked that ring-like smooth ledge which borders the terminal sieve-plate, and which, though in many cases merely suggested, attains in others a height of 10 mm. Usually, however, the "cuff" is not in direct connection with the rest of the ridge system, but is separated from it by a concave circular zone varying from 5 to 10 mm. in breadth. It is distinguished from the other ridges by being thinner, and by possessing sharper edges.

On the inner surface of the wall of the tube may be observed a tolerably regular system of circular and longitudinal ledges, which together form a quadrate lattice-work. The circular ledges, however, extend somewhat further inwards than the longitudinal. The quadrate meshes which are thus formed have a breadth of 3 or 4 mm. They differ essentially from one another, inasmuch as the one series exhibit in their centre the circular parietal gaps already mentioned, with several minute grooves at the circumference, while the others only show one or more furrow-like grooves of various breadth and depth. The areas which exhibit deep furrows correspond to those ridges which are prominent externally, while the shallower grooves underlie the simple elevations that occur between every four gaps, in those regions which are not provided with ridges. The arrangement of the parietal apertures in oblique spiral rows, and the rhombic form of the areas occurring between every four adjoining gaps, are conditioned

by the fact that the perforated meshes alternate (with tolerable regularity) both longitudinally and transversely with those which are closed (Pl. IV. fig. 2).

The number of transverse ridges projecting inwards amounts to sixty or eighty in a full-grown specimen. I have counted thirty longitudinal ridges on the upper portion, and about twenty in the lower, which agrees tolerably well with the numbers given by Marshall. The increase in the number of longitudinal ridges in the upper part of the tube is due to the splitting which here and there occurs.

The watch-glass-like, arched, terminal sieve-plate consists of a lattice-work of laterally compressed ridges of various thickness, which, though exhibiting no very regular arrangement, yet suggest a wheel-like reticular structure. One can distinguish, at least, three or four main beams which are approximately circular and several which extend radially. These form the primary meshes, which are again divided by narrower and less prominent ridges. Here and there a broader plate is formed in the network, as if by the confluence of the stronger beams.

At the lower end of the body the longitudinal bundles of siliceous fibres gradually emerge on the surface, and breaking up into separate spicules, form the basal tuft. This has a length of from 4 to 8 cm., is tube-like in its upper portion, but towards the lower end becomes brush-like through divergence of the component fibres. This tuft accordingly encloses a central inversely conical cavity, into which the extreme lower end of the lattice-like skeleton of the tube-wall extends downwards for a variable distance. In all full-grown specimens I found that this extreme end of the tube was dead, and at a distance of several centimetres from the terminal opening, which is from 1 to 2 cm. broad, the end of the tube was devoid of all soft tissue, in fact macerated and generally filled with a firm stopper of mud. The younger the specimen examined, the better was the preservation of the lower end of the tube, and the narrower the terminal opening. I was, however, unable to discover, in any of the specimens at my command, any "pointed terminal cone, formed from the longitudinal and spiral strands of the parietal tissue," such as Marshall has observed in a very young specimen, and has designated the "inferior sieve-plate."

In uninjured specimens whose soft parts had been well hardened by being preserved in absolute alcohol, no external openings except the parietal gaps could be seen with the naked eye. The sponge was of a pale yellowish-grey colour. The consistence of the soft tissue which covered the skeletal framework in a somewhat thin layer resembled that of *bread crumbs*, while Wyville Thomson in The Atlantic, p. 136, observed:— "In fresh specimens of *Euplectella aspergillum* the crystal framework is covered and entirely masked by a *layer of grey-brown gelatinous matter*."

The perforated dermal membrane, which is beset with numerous, small, conical protuberances, extends smoothly over the much folded chamber layer, and is connected with it only by the outer trabecular framework, which is much riddled by the subdermal spaces

and by the incurrent canals (Pl. IV. fig. 4). The saccular chambers which lie adjacent to one another have either grown together laterally, at the points of contact, so as to form narrow longitudinal stripes, or are connected by means of short beams (Pl. IV. figs. 4, 6).

The interspaces and canals extending from the apertures of the outer trabecular framework, and passing in between the chambers, are terminated by a connecting membrane which is stretched, as a direct continuation of the chamber walls, between the margins of the chamber orifices.

The inner trabecular framework, on the other hand, together with the internal perforated skin, which is known as the *gastral membrane*, enters the excurrent canals and lines them as far as the orifices of the chambers (Pl. IV. fig. 4).

Without entering here more minutely into the histological relations of the soft parts thus generally referred to, I would merely note, that in some cases I found, both in the inner and in the outer trabecular framework, numerous sperm-balls, and also ova of different sizes (up to 0·3 mm. in diameter), filled with round yolk-granules. In all these ova it was peculiarly remarkable that the germinal vesicle which contained a large nucleolus was protruded outwards, and lay on the surface in a round hollow pit-like depression of the surface.

The Skeleton.—The filagree-like lattice framework, which is readily obtained by macerating older specimens, as also the spicules which lie freely in the soft tissue, are so well and so accurately described by such earlier observers as Owen, Claus, Marshall, and Carter, that I content myself with referring to their excellent works, and will here only briefly note the more important points in connection with the architecture of the skeleton, characterise the different kinds of spicules according to their form and arrangement, and discuss, at greater length, some points which have hitherto been but little noted.

The groundwork of the entire continuous tube-skeleton consists of two layers of beams crossed at right angles. One of these layers, the inner, is composed of circular strands of fibres, while those of the outer have a longitudinal direction. Both together form a lattice-work which is more clearly recognisable on the inner side, and which exhibits quadrate meshes, varying from 3 to 5 mm. in breadth. Outside these two layers of beams, and partly also between them, are two other systems of intersecting fibres, which run diagonally to the former, and surround the tube in opposite directions in *oblique spirals*. They are particularly obvious on the outer side of these quadrate meshes of the main lattice-work which neither have parietal pores, nor are covered by external ridges. These externally protruding elevations or ridges are supported by two layers of steeply-set beams, which lie just beneath the two lateral surfaces, and which, like the opposite rafters of a very steep roof, have their outer ends united at an acute angle corresponding to the sharp edge of the ridges. They are also firmly fused laterally to one another, and to the strong lattice-work of the tube (Pl. IV. fig 3). These rafter-like

beams are crossed on the one hand by long spiral fibres, which run parallel to the edge of the ridges, and on the other hand by small short beams, which run through the ridges transversely. The ridges are doubtless to be regarded as folds of that part of the tube-wall which extends over those meshes of the inner quadrate lattice-work not occupied by parietal gaps, and which is supported by spiral fibres crossing one another obliquely. The long ridge-fibres running parallel to the margin are to be looked upon as a direct continuation of one of the two systems of spiral fibres, which cross one another obliquely, and further, the rafter-like beams which intersect the former at right angles are to be ascribed to the other system of those spiral bands. The latter appear in the ridges as if laid in a fold sharply involuted on the outer extremity (Pl. II. fig. 8).

The strong circular and longitudinal fibrous bands, which are so manifest on the inner side of the macerated tube, have for their groundwork the much drawn-out, strong rays of the regular, simple and cruciform tetracts. These are interwoven in a peculiar manner, and become subsequently firmly united by cementing matter and synapticula. While all the circularly arranged rays of these tetracts run along the inner side of the tube, the longitudinal rays on the other hand lie transversely across the outside, and all the rays extend over several adjacent tetracts, thus producing the interlacing which is suggested in Pl. II. fig. 2. The long siliceous fibres which form the basal tuft join the longitudinal beams of the quadrate network externally, from the commencement of the inferior third portion of the tube.

The narrow, much prolonged comital spicules, which are closely applied by the two long rays of their principal axis, partly to the circular rays and partly to the longitudinal rays of the large tetracts, and which at a later period become fused together, are for the most part triacts (Pl. II. fig. 4; Pl. III. fig. 12), whose unpaired ray is continued into the oblique spiral bands of the tube-wall, or contributes to the formation of the ridges. More rarely the comital spicules are diacts or irregular tetracts, in which the longer rays lie in one and the same axis, while the two other shorter rays are placed at right angles to one another (Pl. III. fig. 20).

The oblique spiral bands of fibres which extend over the covered meshes of the quadrate network, and the firm margins of the parietal gaps, are chiefly composed of the long principal axes of triacts. Here and there irregular tetracts also occur, and diacts whose atrophied transverse axes are usually more or less prominent owing to the presence of prongs.

Pentacts and hexacts are less frequently found among the thread-like elongated spicules (Pl. III. fig. 17).

The extremities of all those needles, which are subsequently firmly united, exhibit remarkable modifications, a few of which are figured on Pl. III. figs. 2–10. The rays seldom run out to a point, with a gradual decrease of diameter (Pl. III. fig. 2); in most

cases the extremity is conical and sharp (Pl. III. figs. 3–5) or simply rounded (Pl. III. figs. 7–9). It is either smooth or provided with small knobs. These prongs or knobs, which project obliquely outwards, give the ends the appearance of club-like thickenings (Pl. III. figs. 9, 12, 17, 20, 25), but this may be also exhibited by smooth extremities (Pl. III. figs. 10, 14).

The tuft of siliceous spicules, rooted in the mud, is formed of two essentially different kinds of spicules, the main difference between which may be shortly noted by the designations "pronged diacts" and "smooth pentacts." Both begin in an upper, pointed, smooth extremity, and run out into an anchor. But, while in the comparatively rare smooth pentacts the intersection of the axial canals lies in the centre of the four anchor teeth, which are always crossed at right angles, and while not only the long smooth anchor stalk, but also each of the four upwardly bent anchor teeth is traversed longitudinally by an axial canal (Pl. III. figs. 22, 23), the intersection of the axial canals in the pronged diacts does not occur in the greatly thickened inferior terminal knobs but somewhat above this in the spinose stalk (Pl. III. fig. 29). Inferiorly the axial canal runs out generally in a penicillate fashion into a variable number of diverging branches. The smooth anchor teeth of the prong-bearing diacts, which (to the number of three to eight or more) stand in a whorl on the side of the terminal knob, and project outwards or upwards, possess no axial canal (Pl. III. fig. 29), and are accordingly to be considered not as true rays, but only as lateral outgrowths like the prongs of the stalk. The tuft spicules may in full-grown specimens attain a length of 10 cm. or more. During growth they project downwards and outwards from the longitudinal bundles of fibres in the tube-walls, and spread out in a brush-like manner. A bending back of the fibres against the lateral walls of the tube does not normally occur. Predominant among the spicules which form the upper sieve-plate, and which are distinguished by their particularly firm union, are strong triacts with distorted angles, and diacts whose two rays either form a plain arch or an obtuse angle. Regular cruciform tetracts, or pentacts and hexacts, seldom occur here.

In addition to the spicules above referred to, which become for the most part firmly united, there are numerous isolated spicules in the parenchyma of the soft parts, as well as in both the limiting membranes. These compose the so-called flake-like tissue ("Flockengewebe" of authors). This designation is due to the resemblance which the heaps of such needles, liberated by maceration and dried, bear to flakes of snow. As the age of the sponge increases some of them become cemented together, while others remain isolated throughout life. Among the former are numerous delicate spicules with a variable number of rays, but for the most part triacts, which in their whole appearance resemble the long and thin comital spicules above referred to, but which possess outwardly bent rays not so long as those of the comitalia (Pl. III. fig 25). The spicules which always remain isolated may be classed in the following five groups:—(1) parenchyma spicules, which are distinguished by thick, short, pointed rays, uniformly conical towards the outside ;

(2) hexact hypodermalia; (3) pentact hypogastralia; (4) oxyhexasters scattered among the parenchyma; (5) protuberant floricomes.

The spicules which belong to the first category, and are provided with thick, short, conical rays, are scattered in the inner portion of the walls of the tube. They are particularly abundant, and are arranged in a cruciform manner in the circular membrane surrounding the parietal gaps. In this situation pentacts chiefly occur, in which the unpaired ray penetrates the parenchyma radially outwards, while the four rectangularly crossed rays of the two other axes lie parallel to the bounding surface. Often, however, (especially in the inner thinner marginal portion of the circular membrane), only one of the two latter pairs of rays is fully developed, so that triacts arise whose paired rays, lying in the same axis, extend tangentially to the free margin of the parietal gaps, while the unpaired ray is directed radially. If, again, the latter remain undeveloped, diacts arise which have been designated by Marshall "compass-spicules" on account of their resemblance to a compass needle, being much swollen in the middle. Completely formed hexacts belonging to this category of spicules are less frequent; when they occur they lie in the parenchyma at some distance from the gastral surface, or from the free margins of the parietal gaps. They are usually regularly developed (Pl. III. fig. 18), more rarely shortened in one ray (Pl. II. fig. 1, *a.b.c.*). While in the lattice-like network of the outer skin *dermalia* proper are absent, regularly arranged *hypodermalia* occur underneath as slender hexacts of equal form and size, and provided with a greatly prolonged proximal ray, four times longer than the other five rays, which are of approximately equal length, and like the former run gradually out to a point (Pl. III. fig. 16; Pl. IV. figs. 3, 4, 5). The long principal axis is at right angles, the two transverse axes are parallel to the surface of the body.

In well-preserved portions the axial cross of the hypodermalia lies about 0·1 mm. beneath the skin. Their distal ray extends into a point-like elevation of the skin, which it seems to push out. On its outer end it carries a floricome which extends over the skin (Pl. IV. fig. 4).

Since the corresponding tangential rays of the neighbouring hypodermalia are apposed to one another laterally for half of their length or even more, quadrate or rectangular meshes are formed, over the centre of which the skin is, as a rule, somewhat depressed (Pl. IV. fig. 4). If this involution extends still further, the skin finally becomes applied closely against the tangential rays of the hypodermalia, and it may even seem as if the latter occurred in the skin. On the summit of the outer ridge there is usually a row of particularly strong and long hypodermalia.

To the system of the hexact hypodermalia there corresponds, on the inner side of the entire tube and of the large excurrent passages, a system of similar slender pentact hypogastralia with pointed extremities (Pl. III. fig. 13; Pl. IV. fig. 3). These occupy the same relative position to one another and to the gastral limiting membrane of the

inner trabecular framework as the hypodermalia do to the outside skin. The long unpaired distal ray extends into the parenchyma, while the four short rays of the two other axes form a cross which lies close beneath and parallel to the gastral membrane. Though this system of hypogastral pentacts also extends for a considerable distance into the excurrent passages, it does not extend as far as their terminal diverticula (Pl. IV. fig. 3).

The numerous rosettes present in the parenchyma are all oxyhexasters whose short compressed principal rays are continued with a slight terminal thickening into the strongly diverging, straight terminal rays which are six times longer. The number of terminal rays belonging to a principal ray varies from two to five, and it is the same in most cases on all the six arms of a rosette, though it may differ in individual arms. The most common case is for every arm to have three terminal rays (Pl. III. fig. 1).

Such oxyhexasters occur on the one hand in the outer trabecular framework, with which they are compressed between the convex outer sides of the chambers; and on the other hand, in the inner trabecular framework, with which they extend to the final expansions of the excurrent canal system, between and in front of the terminal openings of the chambers. They do not occur, however, either in the chambers themselves or in their delicate walls. The dermal and gastral membranes are also free from them.

The other rosette, much more striking on account of its elegant form and exposed position—the floricome—is regularly distributed over the whole outer skin, and is scattered on the tips of the conical elevations of the skin into which the distal extremity of a hypodermal hexact extends (Pl. IV. figs. 3, 4, 5).

Each of the six short, narrow, principal rays becomes divided into seven or eight terminal rays, which are bent in an S-like manner, are arranged in a whorl like the petals of a lily, and consist of a very thin basal portion or stalk, slightly bent and convex towards the outside, and of an outer portion which gradually increases in thickness. The latter bends outwards in a stronger curve, and ends in a firm, almost hemispherical plate, whose sharp semicircular outer border is prolonged into six or eight claw-like prongs (Pl. II. fig. 9; Pl. III. fig. 11).

Since these terminal rays of the floricome usually project freely from the pointed elevations of the skin, either entirely or with their claw-bearing extremities, they penetrate any soft body which may come in contact with the sponge. The delicate stalk will then readily break off, and the terminal portion remain in the foreign body. In this manner the floricomes of the *Euplectella* serve as weapons of defence against the attacks of soft skinned animals such as fishes, molluscs, worms, and the like.

I observed that most floricomes had one of their axes so applied to the distal ray of the corresponding hypodermal hexact that they lay at right angles to the surface of the skin. Not unfrequently, however, I found them also lying obliquely as if misplaced. Though floricomes are not to be found on many, and especially on prominent portions of the skin, it may be reasonably supposed that they were originally present here as well as

in the adjoining and more protected regions, where they occur in a perfectly regular arrangement. Even on the outer side of the beams of the sieve-plate I have frequently found them intact over large areas. On the borders of the parietal gaps, as well as on the entire inner surface of the sponge and the excurrent passages, they are entirely absent, nor have I found them in the parenchyma.

Among the many examples of this beautiful and interesting species which the Challenger Expedition collected from the same locality, namely, near the island of Zebu, at a depth of 100 fathoms, some young specimens, unfortunately much injured, of which two seemed bound together by an oblique tube-like anastomosis, deserve special mention. The larger of these two tubes, which stand almost parallel to one another at a distance of 2·5 cm., is bent in a hook-like manner, and just above the connecting bridge, on the side turned towards the other specimen, is somewhat flattened and partly involuted. Not including the basal tuft, it is 20 cm. long, and from 2·5 to 3 cm. broad. The distance between longitudinal and transverse spicular bundles is from 2 or 3 mm., the breadth of the tolerably regular parietal gaps is about 1 mm. The outer ridges and the cuff are well developed, and they attain a height of 2 or 3 mm. The terminal sieve-plate is remarkably highly arched. Somewhat above the middle there is an acutely angular division of the tube into two similar tubular branches. The one branch continues in the direction of the principal portion to the highly-arched terminal sieve-plate with an approximately equal diameter; the other bends obliquely to the side, becomes somewhat narrower, and is continued directly into the wall of the second shorter and narrower straight tube, of 10 cm. in length, and 1 to 5 cm. in transverse diameter. This extends for 2·5 cm. to the inferior funnel-like narrowed extremity, which runs out into a delicate basal tuft, while the upper very delicate and soft portion is about 6 cm. in length, and is provided with a terminal sieve-plate. This small specimen was unfortunately much damaged in its delicate upper part, yet it may still be clearly recognised that longitudinal bundles of fibres pass over directly from the larger *Euplectella* through the obliquely ascending bridge into the longitudinal strands of the smaller portion, and extend both upwards and downwards. Since the portion of the short tube which lies beneath the connecting bridge, and especially that part towards the larger tube, agrees thoroughly in the character of its wall with the side branch of the larger tube, it apparently represents a direct continuation of the latter; the upper portion, on the other hand, up to its superior sieve-plate, becomes gradually narrower in its meshes and enfeebled in all its parts, and is, moreover, manifestly younger than the under portion, so that I do not think we have here to deal with two independent specimens which stood close to one another, and which, at a subsequent period become united by a binding-tube, but am rather of opinion that originally only the larger existed. A portion of the upper half of its lateral wall was separated from the upper half in such a way that it hung down to the ground in an arch. This arch thereupon

united so as to form a tube, which constituted the present connecting bridge and the under extremity of the small tube, while from its upper convex side a new young tube grew upwards.

Another young specimen, in which the amalgamation of the spicules has not yet commenced, is from 2·5 to 3 cm. broad, possesses a highly arched sieve-plate, and a very well developed system of ridges, together with a completely formed cuff. The ridges have already attained a height of 3 mm. or more. The inferior extremity is unfortunately absent.

2. *Euplectella suberea*, Wyville Thomson (Pl. V.; Pl. VI. fig. 3).

Though the Challenger specimens of the new species which Wyville Thomson named *Euplectella suberea* were not, as a whole, well preserved, the discoverer was still able by combining the various fragments, to obtain so perfect a conception of the size, form, and structure of the whole sponge that he was able to publish, with the help of the artist, the restoration presented in Pl. V. fig. 1. As is evident indeed from this excellent figure, and from Wyville Thomson's own words, which have been quoted verbatim above on p. 60, the sponge in question is a straight, round, slightly swollen tube, varying from 20 to 25 cm. in length, and measuring about 5 cm. in its greatest breadth. Its walls, it is true, present a general similarity to those of *Euplectella aspergillum*, but it may be readily distinguished from the latter by the greater regularity of its structure, by the absence of the high external ridges and of the cuff, as well as by the numerous separate projecting radial spicules.

The parietal gaps lie at a distance of 6 to 8 mm. from one another, within trench-like pits, which are connected by intersecting systems of external, oblique, and spiral furrows, so that the regular spiral arrangement of the parietal apertures becomes all the more manifest. Between every four adjoining parietal gaps there is a rhombic area, bounded by the connecting furrows, and provided with a flat, slightly convex, projecting elevation.

The upper transversely truncated extremity of the tube is bordered by a delicate marginal wreath, from which isolated spicules project upwards and outwards in groups, without forming a continuous fringe. Close beneath the margin there is a wreath of densely placed parietal apertures, while inside the margin a wide-meshed lattice-like network is spread out transversely, the delicate strands of which are arranged partly in a circular, and partly in a radial manner.

The inferior extremity of the tube, which has become narrowed to about the half of the greatest transverse diameter, is devoid of soft parts, and runs out into an incompletely preserved basal tuft of long, thin, siliceous fibres.

An examination of the inner surface of the wall shows that here, as in *Euplectella aspergillum*, a quadrate, lattice-like network of longitudinal and circular ridges projects inwards. The meshes are seen to be occupied alternately with a parietal gap, and with a

round exhalent orifice of the efferent canal system which lies underneath every outwardly arched elevation of the walls of the tube (Pl. V. fig. 12; Pl. VI. fig. 3). On the projecting ledges there are also numerous smaller furrows, and the orifices of shorter efferent canals. Although the preservation of the soft parts of the specimens handed over to me for examination is not so good as that of many specimens of *Euplectella aspergillum*, I have still succeeded in definitely determining the essential structural relations.

The much folded layer of saccular chambers is, as in *Euplectella aspergillum*, united with the external skin by means of the outer trabecular framework, and with the gastral membrane by means of the similar internal trabeculæ. In this also, the latter is continued into the terminal diverticula of the efferent passages, forming a continuous internal lining (Pl. VI. fig. 3).

The thickness of the tube-wall amounts, in the arched portions, to about 3 mm., and through the inwardly projecting ledges to between 3·5 and 4 mm.

The chief skeletal framework is formed of strong pentacts, in which the four cruciately disposed rays, which vary from 1 to 3 cm. in length, are arranged longitudinally and circularly so that they are closely apposed to each other longitudinally, or even cross one another transversely, and so that the longitudinal rays always lie externally to the circular. The breadth of the quadrate meshes thus formed amounts to 3 or 4 mm. The radial unpaired ray, which projects freely outwards in a straight or slightly curved course, attains a length of 1·5 to 2 cm., and, like the four other rays, runs out to a simple point. A radial ray does not, however, arise from every point of intersection of the longitudinal and circular fibrous strands; on the contrary, both in the longitudinal and transverse directions, a simple point of intersection without an independent pentact always alternates with one which is occupied by the intersecting nodes and the radial rays of a pentact (Pl. V. fig. 15).

The intersections of these longitudinal and transverse fibres correspond, not to the middle of an elevation lying between four parietal apertures, but to those external furrows which unite the parietal apertures in spiral lines (Pl. V. figs. 1, 12).

The longitudinal, as well as the circular rays of the large pentacts, are closely surrounded by a mantle of delicate comitalia, whose greatly prolonged rays apply themselves either parallel to, or in gentle windings round the thick round pentact-rays. As a rule the comitalia consist of triacts, whose unpaired ray stands at right angles to the two long rays which lie in one line, and serves for the support of the adjacent soft parenchyma. Long diacts with central intersecting nodes are also frequent (Pl. V. fig. 14). The extreme ends of these comitalia form blunt points, and exhibit a slight roughness, while the rest of the ray is smooth. With the comitalia are associated those numerous parenchymalia, with from two to six slightly bent or straight rays (Pl. V. figs. 16–20), which serve for the support of the parenchyma of the soft parts between the principal strands of fibres. They are somewhat thicker than the comitalia, and their

rays are never so much prolonged. Hexacts seldom occur among the parenchymal spicules, and like the somewhat more frequent pentacts are irregularly developed. The numerous tetracts which are present, exhibit, indeed, for the most part, rectangularly intersecting axes, but these seldom lie entirely in a plane, being for the most part uniformly bent towards the surface; it may be that the two rays belonging to one axis run out in the same direction and straight, while the two others are somewhat bent, or are disposed at an obtuse angle to one another. Sometimes tetracts occur with one of the rays disposed at right angles to the surface of the three others. The majority of these parenchymalia have only two or three rays. Of the triacts the two rays belonging to the same axis are usually bent in a slight curve, from about the middle of the convex or concave side of which the third straight ray springs (Pl. V. fig. 16). The diacts are sometimes straight, sometimes slightly bent, pointed at both ends, or more or less rounded. They exhibit in the middle of their axial cross, four, two, or one tubercle, and are frequently roughened, not only near their ends, but throughout.

Peculiar small, straight, rough diacts, with truncated or rounded extremities, and with four tubercles projecting markedly from the axial cross and often exhibiting central terminal points (Pl. V. fig. 7), occur abundantly in the thin circular membrane which surrounds each of the parietal gaps. As a rule, the two rays are equally long, but forms also occur with two long unequal rays, and others which by the very great shortening of one ray have become monacts.

Both in the outer and inner trabecular framework rosettes occur, scattered quite irregularly in the form of oxyhexasters, whose short principal rays bear usually three (Pl. V. fig. 2), seldom four, straight, long, more or less stout terminal rays. The rosettes represented by Wyville Thomson on Pl. V. figs. 3, 8, I have only discovered in those greatly damaged fragments which were much mixed with the spicules of other Hexactinellida, and which were collected off the coast of Brazil (Station 124). These latter rosettes probably do not belong to *Euplectella suberea*, but appear to me to have originated in other Hexactinellida, and to have become accidentally embedded in these specimens. At least in sections of *Euplectella suberea* (collected to the west of Gibraltar), I have never been able to find such rosettes *in situ*.

The dermal skeleton consists of a layer of dagger-like delicate hypodermal hexacts with rough conically pointed extremities, which have their tangential rays so apposed to one another under the bounding membrane that a rectangular meshwork is formed, while the proximal ray penetrates deeply into the parenchyma, and the distal ray, extending to the very tip of every minute tubercle of the skin, bears the somewhat freely projecting floricome (Pl. VI. fig. 3).

It is noteworthy that on the top of those flat archings which project outwards between every four parietal pores, the much prolonged distal ray of a specially large hexact usually projects at right angles to the surface, and instead of carrying a floricome

is surrounded by a bundle of diacts, which are provided with prongs on their pointed extremities (Pl. V. fig. 6), and have four conical swellings on the axial intersection.

The floricomes of the outer skin exhibit a form quite similar to that in *Euplectella aspergillum*, but it is important to note that they are almost twice as large. I usually found seven terminal rays on each principal.

The *gastral skeleton* exhibits on the inner side of the quadrate ledge-like network which projects into the large lumen of the tube the same slender pentacts which occur in similar positions in *Euplectella aspergillum;* on the other hand, on the inner side of the diverticula-like chambers which underlie the external gentle archings, slender dagger-like hexacts occur, with a prolonged distal ray, and a proximal ray projecting radially into the inner lumen (Pl. VI. fig. 3), raising the gastral membrane into pointed tubercles, and bearing on its end a floricome just like the similar dermal hexacts. It is interesting, however, that this gastral floricome does not agree either in size or form with the above-mentioned dermal floricome. The number of the terminal rays belonging to each principal amounts to ten or twelve in the former, but only to seven in the latter. The cup formed by these terminal rays is relatively broader (the diameter of the whole floricome is only half as large as in the case of the dermal floricome) (Pl. V. fig. 4).

Fragments of *Euplectella suberea*, Wyville Thomson, were collected by the Challenger in three different places :—

(1) In 600 fathoms, lat. 36° 25′ N., long. 8° 12′ W.; Station IV.; west of Gibraltar.

(2) In 1090 fathoms, lat. 35° 47′ N., long. 8° 23′ W.; Station V.; west of Gibraltar.

(3) In 1600 fathoms, lat. 10° 11′ S., long. 35° 22′ W.; Station 124; between Pernambuco and Bahia.

The figure (Pl. V. fig. 1) is reconstructed from somewhat defective, and yet in some respects adequately preserved, specimens found to the west of Gibraltar (Stations IV., V.).

In a short review of the results of the French "Travailleur" expedition, Milne-Edwards[1] has noted (1881) that "two fine specimens of *Euplectella suberea* were taken off the Berlingues at 3307 metres." And Filhol[2] adds, "Les Euplectella suberea sont largement répandues dans l'Atlantique nord. Pendant la croisière du Talisman nous les avons draguées à diverses reprises par des fonds variants entre 900 et 2300 mètres. En certains points elles étaient d'une extrême abondance et devaient couvrir d'assez vastes capaces."

3. *Euplectella cucumer*, R. Owen.

Since I had the opportunity of seeing the original specimen of *Euplectella cucumer*, Owen, which is preserved in the British Museum, and of examining it so far as was possible without injuring the beautiful specimen, I shall here take the opportunity of briefly expressing my opinion in regard to this interesting form.

[1] *Comptes rendus*, xciii. pp. 871–931; *Ann. and Mag. Nat. Hist.*, ser. 5, vol. ix. p. 46.

[2] La vie au fond des mers, p. 282, pl. iii.

In opposition to the opinion which has been expressed by several authors, *e.g.*, Marshall,[1] to the effect that *Euplectella cucumer* is not specifically distinct from *Euplectella aspergillum*, I must point to the following essential differences. Whilst *Euplectella aspergillum* has the form of a bent tube, which becomes wider towards the upper extremity, *Euplectella cucumer* consists of a perfectly straight, bellied tube, devoid both of the externally projecting ridges and of the cuff on the upper margin. The regularity of the arrangement of the round parietal apertures, which is frequently interfered with in *Euplectella aspergillum*, is everywhere manifest in *Euplectella cucumer*. The fusion of the skeletal spicules which appears in all parts of the tube of *Euplectella aspergillum* soon after the attainment of its full size, has taken place in this obviously old specimen of *Euplectella cucumer* only to a very limited degree in a few regions.

It thus appears to me that (on the whole) *Euplectella cucumer* is more nearly related to *Euplectella suberea* than to *Euplectella aspergillum*. From *Euplectella suberea*, however, it may be distinguished first by the compact sieve-plate, consisting of strong, firmly united spicules, and secondly, by a character which Owen noted, and which Carter subsequently announced as a distinctive peculiarity,—the possession of strong hexacts, 1 to 2 cm. in length, regularly distributed in such a way that one always occurs in the middle space between every four adjoining parietal gaps, with its strong distal ray projecting freely from the summit of the raised arching of the outer wall.

From such considerations I believe I am justified in maintaining that *Euplectella cucumer*, Owen, is an independent species.

4. *Euplectella jovis*, Oscar Schmidt (Pl. VI. figs. 4, 5).

According to Oscar Schmidt's account *Euplectella jovis*—found in the Gulf of Mexico, in 423 fathoms in the neighbourhood of St. Lucia, and in 416 fathoms in the vicinity of Granada—agrees in many points with *Euplectella suberea*, Wyville Thomson. The straight tube, which extends to a length of 50 cm., is provided with a basal tuft and a terminal sieve-plate; but the external ridges are absent. A projecting wreath of spicules surrounds the sieve-plate. The round parietal gaps are arranged in spiral rows, though not quite regularly (Pl. VI. fig. 4). On the inferior extremity O. Schmidt found a transversely placed inferior sieve-plate which divided the inferior conical portion of the tube, which was filled with mud, from the principal vital portion.

As the spicules never become fused the tube remains soft and flexible.

The intersections of the longitudinal and transverse strands of fibres forming the quadrate lattice-like network are here also principally supported by the mutually apposed tangential rays of the strong pentacts, whose distal radial ray projects freely outwards, for a distance of 1 or 2 cm. beyond the surface. An intersection of the fibrous lattice-work, pro-

[1] *Zeitschr. f. wiss. Zool.*, Suppl.-Bd. xxv. pp. 148, 209.

vided with such a pentact and distal ray, always alternates both in the longitudinal and in the transverse direction, as in *Euplectella suberea,* with an intersection without a pentact.

Both the tangential rays and the basal portion of the distal ray are surrounded by numerous greatly extended comitalia which are for the most part triacts. Over the meshes of the lattice-work which are not perforated by parietal gaps, there extend spiral strands of thin, elongated parenchymalia, which cross each other obliquely, and which are also for the most part triacts.

In the circular membrane which surrounds every parietal gap there occur near the free inner margin numerous short blunt monacts of a sceptre-like form, whose five reduced rays project at the one end as short rounded stumps or hemispherical knobs (Pl. VI. fig. 5). The occurrence of this form has induced O. Schmidt to dedicate the species to Jupiter. Besides the fully formed sceptre spicules numerous diacts also occur with projecting cruciate axial knots, which show very clearly how the sceptres have arisen.

More characteristic than those sceptres, which also occur singly in *Euplectella suberea,* are the clasps or fibulæ which are scattered with comparative uniformity throughout the whole parenchyma of *Euplectella jovis.* These exhibit a straight, thick, middle portion with a central node and two curved hook-like terminal rays which run out to fine points (Pl. VI. fig. 5). The latter are as a rule clearly marked off from the middle part, but their curves usually lie in different planes, turned towards opposite sides, so that when seen in a certain direction they seem to present the figure of an S. I regard these clasps, which I also met with in *Holascus fibulatus,* as derived from oxyhexasters with bent terminal rays. I do not derive them from simple hexacts, because on each side a terminal ray springs from the corresponding principal ray. Important also in this respect is the generally very clearly developed median node, on which four lateral tubercles may sometimes be seen. Here and there triacts or tetracts may also be seen whose rays have the same form as in these diact fibulæ. This interpretation also harmonises with the fact that in *Euplectella jovis* the oxyhexasters which are present in all other species of *Euplectella* do not occur, but are, as might be expected, converted into the clasps.

On the outer surface of the distal ray of the sword-like hexact-hypodermalia, large floricomes occur with a small number of terminal claws exactly as in *Euplectella suberea.*

5. *Euplectella owenii,* Herklots and Marshall (Pl. VI. figs. 1, 2).

1868. Herklots and Marshall, Arch. Néerl. des sci. nat., iii. p. 435.
1875. Marshall, Zeitschr. f. wiss. Zool., Bd. xxv., Suppl., p. 142.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii., p. 113.

Of that elegant Japanese *Euplectella,* which was first described by Herklots and Marshall and named *Euplectella oweni,* no specimens were brought home by the Challenger Expedition. There occurs, however, a relatively well-preserved specimen of this species among those Japanese Hexactinellida which were handed over to me by Dr. Döderlein of

Strassburg. Including the basal tuft this form has a length of 20 cm. The portion which projects freely from the mud is 12 cm. in length, and its cross section is oval, the long axis below measuring 35 mm., but above, just below the dome-like arched sieve-plate, only 25 mm.; the short axis beneath measures 30 mm., and above 22 mm. A comparison of these figures with those recorded by Marshall for his specimen, shows that we have here to deal with a relatively small, and probably young specimen. In form it agrees throughout with Marshall's sketch and figure,[1] exhibiting a straight tube whose diameter is greatest somewhat beneath the inferior third part, and diminishing upwards at first very gradually, finally somewhat more rapidly, becoming narrowest just beneath the terminal sieve-plate. Both cuff and external ledges are entirely absent. The inferior extremity is continued with a more gradual narrowing into the long, soft, hair-like basal tuft.

The arrangement of the round parietal gaps, which are almost 1 mm. in diameter, in regular, transverse and longitudinal rows is very manifest. Between these parietal gaps, which lie in pit-like depressions, a rectangular lattice-work of transverse and longitudinal elevations projects both in the outer and inner surfaces (Pl. VI. fig. 1). A system of rectangularly crossed longitudinal and transverse bands of fibres, of which the latter project most internally, while the former cross them transversely on their outer side, serves for the support of this lattice-work, which forms somewhat narrower meshes at the upper than at the lower end. Transverse fibres also occur, and these become interwoven with the system of longitudinal fibres, sometimes occurring above, and sometimes beneath the latter. The longitudinal and the transverse bands of fibres do not always form, as in *Euplectella aspergillum*, simple and compact bundles, but frequently consist of two separate, but parallel bundles which lie close together, or at some distance from one another. Marshall describes these double bands of fibres as somewhat constant and characteristic of the species. In the specimens before me the division only occurs here and there, and is most marked in the longitudinal bundles (Pl. VI. fig. 1). The circular fibrous bands exhibit this peculiarity only in the upper region of the sponge. I believe, however, that this peculiar condition of the bands of fibres is of essential importance for the characteristic architecture of the sponge, and especially for the nature and method of its growth. Since the spicules do not here become firmly bound to each other, the elements of each individual band of fibres may readily become laterally separated. If this occurs in every two parallel bundles by a simple division both of the longitudinal and circular bands, perfectly similar new rows of quadrate meshes become formed, which are arranged strictly in longitudinal and transverse directions. A few particularly strong fibres always lie in the axis of each of these longitudinal and transverse bundles of fibres. These are the much prolonged rays of those strong tetracts whose axial cross corresponds exactly to the intersections of the

[1] *Loc. cit.*, pl. xii. fig. D.

bundles. The comitalia, which for the most part compose the fibrous bundles, are, on the other hand, very much prolonged triacts with short transverse rays; more rarely they are diacts or tetracts. Inferiorly and in the outer part of the longitudinal bands of fibres numerous diacts always occur with abundant barbs and with inferior anchors on whose knob-like thickened extremities an indefinite number of anchor teeth form a projecting wreath. I have not found pentact anchors such as occur in the basal tuft of *Euplectella aspergillum* (Pl. III. figs. 23). Between the bundles of longitudinal and transverse fibres, which intersect at right angles, oblique or spiral fibrous bands alone occur. These are, on the whole,[1] somewhat more loosely compacted than those formed from the tetract principalia just described, and consist almost exclusively of very long thin triacts with short transverse rays, and more rarely in part also of diacts and tetracts. Sometimes some spiral bands also extend over the outer side of the longitudinal and the inner side of the transverse beams, or pass over some longitudinal bands externally, then along their inner side between the longitudinal and transverse beams for a certain distance, again passing outwards, and so on. Since each of the quadrate principal meshes, which are from 3 to 5 mm. in breadth, encloses a circular parietal gap, the obliquely crossed bands of fibres cannot lie along the diagonal line of the meshes, but pass close to the parietal foramina, and assist in forming their margins. In this way a woven meshwork is formed, which—as Marshall has pointed out—somewhat resembles that of our common cane-bottomed chairs. The parenchymalia which lie between the long spicules of the principal bands of fibres are for the most part triacts, pentacts and diacts with slightly bent rays, also small normal hexacts and oxyhexasters less regularly arranged. In general they resemble the corresponding structures of *Euplectella aspergillum* so completely that I may refer to the description and figures given for that species. It is only in the circular membrane, which surrounds the parietal foramina, that the parenchymal spicules—as has also been noted by Marshall—present a somewhat different character, since in this locality and in the neighbourhood of the free margin substantial spindle-like diacts with four or two median tubercles occur in great numbers. These Marshall[2] has happily designated compass spicules. Passing from the outer portion of the iris-like circular membrane towards the interior, all transitions from the circular hexacts to those peculiarly deformed diacts may be observed. While externally greatly prolonged curved diacts occur beside the isolated strong hexacts and the numerous pentacts, further towards the interior it may be seen that tetracts and triacts of the same strength predominate, while just at the innermost margin compass spicules are almost exclusively found.

There may also be observed a system of slender dagger-shaped hypodermalia with

[1] The long tetracts which are represented by Marshall in his diagramatic figure (*loc. cit.*, pl. xv. fig. 54, *cc*), as principalia of the oblique spicular bands, I have sought for in vain in this young specimen.

[2] *Loc. cit.*, pl. xv. fig. 57.

greatly prolonged proximal rays, and distal rays which raise the dermal membrane into pointed elevations, and bear on their extremities somewhat freely projecting floricomes.

Bundles of very fine raphide-like spicules, which lie close upon the outer ray of the hypodermalia, appear to me to occur here in greater abundance than in *Euplectella aspergillum.*

The gastralia are slender pentacts with prolonged distal rays, while their atrophied sixth ray often appears as a rounded, more or less projecting tubercle.

The composition of the much arched sieve-plate does not differ essentially from that of *Euplectella aspergillum.* In the basal root-tuft I found anchor-like structures similar to those of the latter species.

Among the Japanese Hexactinellida of Dr. Döderlein there occurs—in addition to the specimen of *Euplectella oweni* upon which the foregoing description is founded—a completely macerated and much injured, though coherent tubular skeleton, which may also with probability be referred to *Euplectella oweni.* This forms a tube of 32 cm. in length, somewhat compressed on one side. At the (3 to 5 cm.) wide extremity, the spicules seem loose, but they are fused below into a firm lattice-work. Since not only the position and arrangement of the bands of fibres, but also the structure of all the larger and smaller spicules which I was able to isolate by tapping, fully agree with those of *Euplectella oweni,* I do not doubt that this specimen is simply a very large and old fragment of *Euplectella oweni,* in which the usually unfused spicules have at a later stage become soldered together.

6. *Euplectella crassistellata,* n. sp. (Pl. XIII. figs. 5–7).

In the middle of the Pacific (Station 274, lat. 7° 25′ S., long. 152° 15′ W., depth 2750 fathoms, bottom Radiolarian ooze) there were found some plate-like fragments from 4 to 6 cm. square, and about 1 mm. thick, along with a narrow tuft of siliceous spicules 6 cm. long, to which a small part of the plate-like mass was still firmly attached. Round or oval apertures from 1 to 1·5 mm. in diameter occur here and there on the plate.

I must regard these fragments as a new species of *Euplectella,* although many characters of this genus are not definitely indicated on account of the insufficient preservation of the fragments.

The principal spicules of the plate are represented by diacts which run out to a point at both ends, and are usually provided with a node-like thickening in the middle. These lie scattered without any recognisable regularity of arrangement, somewhat near the inner surface, and parallel to it.

Besides these and some long thin diact comitalia which are applied closely to the thick principalia, only a few extended spicules are to be found in the parenchyma. Rosettes, however, and a peculiar form of oxyhexaster occur in surprising abundance. These oxy-

[illegible] at the extremities [illegible] XIII. fig. 6).

[illegible] Euplectellidan [illegible] whose proximal [illegible] of the wall [illegible]

[illegible] agree [illegible] mm. [illegible]

The most impo t parts of the quadrate framework consists of strong pentacts, whose greatly prol d tangential rays are placed in apposition to, and across one another in a mann milar to that occurring in the species of Euplectellidæ already described. The un ed ray extends in a radial direction to near the external skin. There is not, howe a special pentact at each of the intersections of the beams of the lattice-work. An i section without a pentact in fact usually alternates, in the longitudinal and transve direction, with one which is so provided (Pl. XIV. fig. 2).

Delicate and m extended comitalia, consisting of diacts, triacts, and tetracts, are closely apposed to strong pentact rays. Besides these the longitudinal strands of fibres contain nume long diacts equipped with upwardly directed barbs, and exhibiting on their inferi xtremities a knob-like thickened anchor-head with three teeth (Pl. XIV. fig. 5). intersection of the axial canal lies above the latter, and is usually marked externally our barbs arranged in a cruciform manner. In addition to the numerous spicules a smaller number of rays, delicate regular hexacts and sparsely scattered rosettes o under the parenchymalia which lie outside the quadrate lattice-work. Among the ttes I found, near the external skin, some lophiohexasters with long bundles of v fine, straight, perfectly parallel terminal rays, and I have also occasionally seen pe tly unconnected oxyhexasters, but whether these belonged to this sponge I was forced leave doubtful, though since then I have been led to regard this as very improbable.

The absence of h oxyhexasters, as are so abundantly present in other Euplectellid species, is very stri , and may perhaps be explained by the fact that the specimen in question is very yo , as it seems to me not impossible that certain forms of spicules only originate at a mewhat late period. Such characteristic spicules as the thick pentacts of *Euplec aspergillum*, or the compass spicules of *Euplectella oweni*, are at any rate entirely a t from the circular membrane surrounding the parietal apertures.

In the dermal s ton the delicate dagger-like hypodermal hexacts with a prolonged proximal ray, whi re so characteristic of the family of Euplectellidæ, exhibit the familiar connectio d arrangement, and in most cases bear a floricome on the projecting distal ray (IV. fig. 2). The floricome in no way differs from that described in *Euplectella asp lum.* On some of these hypodermal hexacts a bundle of freely projecting peculiar cts may be observed in place of the floricome (Pl. XIV. fig. 2). These diacts are di uished by four prongs which project cross-wise in the middle, by the sharp points on outer and inner ends, and by fine lateral teeth or prickles. These lateral prickles ar wever, sometimes absent (Pl. XIV. figs. 3, 4). The gastralia are simple pentacts wi rolonged radial distal rays.

As characterist eculiarities of this young sponge the following features may be noted :—(1) the bun es of pointed diacts which project freely from the lateral wall and are provided with m dian nodes ; (2) the three-toothed anchors of the longitudinal

fibrous bands, and (3) the lophiohexasters which lie near the outer surface, but yet underneath the dagger-like hypogastralia. This form perhaps belongs to the genus *Holascus*.

Genus 2. *Regadrella*, O. Schmidt.

1880. O. Schmidt, Die Spongien des Meerbusens von Mexiko, p. 61.

Regadrella phœnix, O. Schmidt (Pl. XIII. figs. 1–4).

Although *Regadrella phœnix*, which has been described by Oscar Schmidt, is in general characters closely allied to the genus *Euplectella*, remarkable differences occur which may well suffice for the establishment of the genus. We have here, as in the *Euplectella*, to deal with a tube whose walls are much perforated by round apertures, and whose transversely truncated superior extremity is covered by a watch-glass-shaped arched sieve-plate, and bordered by a cuff-like wreath of spicules. The basal tuft is entirely absent, and the skeletal framework consists not of longitudinal and transverse, but of oblique, irregularly interwoven strands of fibres, while the rosettes scattered in the parenchyma are essentially distinct from those of the various species of *Euplectella*. The inferior extremity of the tube has become converted into a compact and substantial cup by extensive fusion of the spicules. The cup is fixed by a knobby base on the stony substratum, while towards the upper end it passes quite gradually into a progressively looser spicular framework. After the death of the sponge the part of the skeleton which is not united by siliceous matter becomes separated from the rest of the body, but the basal part persists, and so admits of the occurrence observed by O. Schmidt, that several generations encapsule one within the other, the younger forms settling within the remnants of their predecessors.

Without entering upon a detailed description of all the individual forms of spicules, I will confine myself to noting the differences between some *Regadrella* spicules and the corresponding spicules of the genus *Euplectella*.

The spicules which project freely from the undulating curved margins of the terminal sieve-plate are hexacts, whose prolonged free distal ray is equipped with scaly or prong-like protuberances (Pl. XIII. fig. 2).

All the rosettes which are abundantly scattered in the parenchyma are distinguished from the corresponding rosettes of *Euplectella* by the fact that their slightly bent terminal rays, three or four of which spring from every short principal ray, do not run out to simple points, but become divided at their narrowed extremities into four transversely directed and cruciately disposed, hook-like, backwardly bent, fine prickles. These forms should thus be designated not oxyhexasters, but rather discohexasters. With regard to fig. 3 on Pl. XIII., which represents a rosette of this kind from *Regadrella*

phœnix, I may here note that the representation of the fine transversely arranged prickles on the extremities of the terminal rays has not been successful.

The floricomes which are attached to the tips of the dagger-shaped hypodermalia differ from those of *Euplectella aspergillum* in their somewhat greater size and stronger terminal rays, as well as in the longer claws of the terminal plates; they thus more nearly resemble those of *Euplectella suberea* (Pl. XIII. fig. 4).

Since no specimens of *Regadrella phœnix* occur among the Hexactinellida collected by the Challenger expedition, I have figured (Pl. XIII. fig. 1), from a photograph, a specimen which was kindly given to me for examination by Professor Oscar Schmidt.

The localities for this species, as at present known, are, according to Oscar Schmidt, the Barbados, in 221 and 288 fathoms of water, and Santa Cruz, in 248 fathoms, in the Gulf of Mexico.

Subfamily 2. Holascinæ (Pl. XIV. figs. 6–13; Pls. XV.–XIX.).

Euplectellidæ in which the lateral wall is solid, that is, *not* perforated by parietal gaps. The principal spicules are not fused together, and form with their longitudinal and transverse rays a quadrate network. The hypodermalia are dagger-shaped, and have a somewhat swollen distal ray beset with prongs, and frequently extended by apposed pointed diacts, but in other cases probably bearing a floricome. The hypogastralia are either simple pentacts without a proximal ray, or hexacts in which the inward projecting (proximal) ray probably can bear a floricome.

Genus 1. *Holascus*, n. gen. (Pl. XIV. figs. 6–13; Pls. XV.–XVII.).

Tubular in form, with a compact wall, the outer surface of which shows no pit-like depressions, while a lattice-work of longitudinal and transverse ledges projects internally. The upper transversely truncated extremity is provided with a thickened margin which is destitute of a spicular wreath, and is closed by a compact sieve-plate, while the inferior extremity runs out into a basal tuft. The network of strands which serves for the support of the body-wall consists of greatly prolonged, longitudinal and transverse rays of compact hexacts, pentacts or tetracts, which lie close to one another, forming a tolerably firm framework, and which are also surrounded by a coating of thin comitalia.

In the parenchyma, in addition to various other spicules, oxyhexasters occur, or instead of these in other cases fibulæ.

The sword-shaped hypodermalia bear no floricomes, but are externally extended by apposed pointed and narrow diacts.

1. *Holascus stellatus*, n. sp. (Pl. XIV. figs. 6–13; Pl. XV. figs. 6–23).

Station 325, east of Buenos Ayres; lat. 36° 44′ S., long. 46° 16′ W.; depth, 2650 fathoms; bottom, blue mud.

At the above locality, the specimen figured in Pl. XV. fig. 6 was dredged, as also the greatly injured fragment of a second specimen represented in Pl. XV. fig. 14. The two specimens differ, moreover, not only in their size, but also in the individual forms of the spicules, so that notwithstanding the general agreement, we have perhaps to deal with two different species.

In the former specimen the almost cylindrical tube, which is slightly widened in the middle (Pl. XV. fig. 6) is 8 cm. long and 13 mm. broad. Upon the upper transversely truncated margin, a terminal circular pad projects somewhat outwards, and this supports transversely the stretched retiform sieve-plate which has been figured by Wyville Thomson (Pl. XV. fig. 6), but which is no longer preserved in the object before me. From their inferior extremity, which is only slightly narrowed, there extends, somewhat to the side, a badly-preserved tuft of fibres about 2 cm. in length. The outer surface of the wall, which is from 1·5 to 2 mm. in thickness, appears to the unaided eye to be roughened by small tubercles, while, with the help of a lens, numerous small pointed elevations showing a uniform distribution and a regular arrangement may be observed in transverse and longitudinal rows. On the inner side pit-like depressions about 1 mm. in breadth likewise occur.

The principalia, which constitute the groundwork of the quadrate lattice-like framework of the tubular wall, are hexacts and pentacts with a distal radial ray. The long longitudinal and transverse rays are so applied to each other that the transverse rays come to lie altogether on the inner side of the longitudinally directed rays. According to the figure given by Wyville Thomson (Pl. XV. fig. 7) it might be thought that the lattice-like network lies close to the inner side of the wall of the tube, and that it consists of nothing but pentacts. Such, however, is not the case. It extends, on the other hand, between the inner and middle third of the thickness of the wall, and consists for the most part of hexacts, between which pentacts with distal radial rays only here and there appear. Numerous thin comitalia, with a variable number of rays, accompany the transverse rays of the principalia. Near the margin of the body, outside the longitudinal strands, long diacts also occur, with pointed upper ends, and with anchor-hooks on their inferior extremities. These diacts are, as a rule, quite smooth above, but bear towards the lower end barbs, which become gradually longer towards the end where the ray passes into a conical pointed thickening, from which usually four, seldom more, anchor-teeth project obliquely outwards and upwards (Pl. XV. fig. 13). Projecting freely downwards for a greater or less distance they form the basal root-tuft.

Among the parenchymalia we must also mention the long, thin, terminally pointed

diacts, which are either scattered at random, or aggregated in bundles. Several forms of rosettes also occur, and in greatest abundance, simple oxyhexasters with short principal rays, and with two to four straight or hook-like, moderately diverging, terminal rays on the extremity of each of the principal rays (Pl. XIV. fig. 13; Pl. XV. figs. 9, 11, 12). The number of the terminal rays may vary from one to three on each of the main rays (Pl. XIV. fig. 8; Pl. XV. fig. 11). These remarkable skeletal elements from whose globular centre four, three, or two rays spring, which are greatly bent in one plane, or even spirally twisted, I regard as arrested derivatives of oxyhexasters (Pl. XIV. figs. 10–12; Pl. XV. fig. 10). In the outer part of the parenchyma, graphiohexasters with close bundles of almost parallel fine terminal rays appear (Pl. XV. fig. 19).

Whether the elegant discohexasters represented in Pl. XIV. fig. 9, which are provided with an S-like terminal ray, and with very small terminal discs, really belong to this species, or are not rather intruded bodies, I have lately begun to doubt.

These and similar discohexasters also appear in that fragment of *Holascus* which is represented in Pl. XV. fig. 14, and the individual spicules are figured after Wyville Thomson in figs. 15 to 23 of the same plate.

The *dermal skeleton* consists of sword-shaped hypodermalia with greatly prolonged proximal rays which run out to sharp points at the extremities, with a thick scaly or toothed distal ray, and with four transverse rays intersecting at right angles, obliquely pointed at the extremity, and of median length. Upon these, as on the proximal ray, small pointed elevations may often be observed.

The tangential arms of these hypodermalia always lie somewhat beneath the dermal membrane, which is raised up in a conical elevation by the distal ray. Close to the outer portion of the proximal ray, and over the whole distal ray,—even extending beyond the outer extremity of the latter,—thin diacts are disposed which run out to points at both ends. These may serve as defensive weapons in place of the floricomes which are here absent (Pl. XIV. fig. 6).

The *gastral skeleton* consists of hexact sword-shaped hypogastralia, in general resembling the hypodermalia, but somewhat more delicate. Thin diacts are here and there apposed to the spicular rays, and are even more delicate than those of the outer skin.

2. *Holascus fibulatus*, n. sp. (Pl. XV. figs. 1–5; Pl. XVI.).

A species of *Holascus*, markedly characterised by the possession of numerous double-hooked fibulæ, is included among the sponges of the Challenger expedition. Three specimens were obtained, one (represented in Pl. XV. fig. 1) in a trawling to the south Australia (Station 160, lat. 42° 42′ S., long. 134° 10′ E.), at a depth of 2600 fathoms, from a red clay bottom; while the other two were got in a trawling which was made in

a locality halfway between Kerguelen Island and the Cape of Good Hope—the one (Pl. XVI. fig. 9) (Station 146, lat. 46° 46′ S., long. 45° 31′ E.) from a depth of 1375 fathoms and a bottom of Globigerina ooze; the other (Pl. XVI. fig. 1) (Station 147, lat. 46° 16′ S., long. 48° 27′ E.) from a depth of 1600 fathoms, and a bottom of Diatom ooze. Although none of these specimens is wholly uninjured, the combination of all the three affords a clear conception of the form and structure of the species. The form can be most clearly recognised from what is really the most macerated specimen, but which is preserved in its entire length (Pl. XVI. fig. 9). This consists of a conical tube, narrowed downwards and running out inferiorly into a basal tuft; while the upper transversely truncated extremity is bounded by a narrow marginal ridge and closed by a sieve-plate which extends within the latter, and is arched slightly outwards in its central portion. The specimen obtained at Station 160 (Pl. XV. fig. 1) represents only the much injured lower end with the basal tuft, while of the decidedly larger specimen from Station 147 (Pl. XVI. fig. 1) only the upper portion with the sieve-plate and the relatively well-preserved soft parts persist.

The whole outer surface of the sponge exhibits the fine small points which occurred on *Holascus stellatus*. Here also on the inner side of the tube there extends a system of intersecting longitudinal and transverse ledges which form quadrate meshes with central pits (Pl. XVI. fig. 1). The framework of the terminal sieve-plate, though not quite regularly constructed, exhibits approximately radial and circular strands of beams, from the intersections and nodes of which small prickles project outwards (Pl. XVI. figs. 9, 10).

The principal framework of the wall of the tube lies towards the inner surface, and consists of strong smooth tetracts. The somewhat long longitudinal rays cross the shorter transversals externally. Numerous comitalia with a variable number of long narrow rays are attached both to the longitudinal and transverse rays of the principalia (Pl. XV. fig. 2; Pl. XVI. fig. 2).

On a transverse section of the somewhat thick wall of the tube (of the fragments figured in Pl. XVI. fig. 1) a system of rough hexacts is observed, with rays disposed in radial, longitudinal, and transverse directions, and apposed to one another to form a framework of beams enclosing cubical meshes (Pl. XVI. fig. 2). The outermost and innermost of these hexacts correspond in position and direction with the hexact hypodermalia and pentact hypogastralia, to the long parenchymal ray of which they are symmetrically joined. The other irregularly scattered parenchymalia consist of isolated graphiohexasters with bundles of long, very delicate, parallel terminal rays, and of those characteristic fibulæ, which I am inclined to derive from greatly reduced oxyhexasters with bent terminal rays. One can frequently observe at some distance from the central nodes and upon each of the two rays a boundary line, at which the straight central, thicker segment passes into the thinner terminal portion (Pl. XV. fig. 3*c*, *d*). I regard this straight, inner, thicker portion as corresponding to the principal ray, the bent outer

portion, on the other hand, as equivalent to the terminal. The fact that the fibulæ are provided with bent terminal rays, instead of the oxyhexasters which are present so abundantly in other species of *Holascus*, is also in agreement with my theory. It has lately been shown that neither the oxyhexasters, nor the prickly small discohexacts, represented in the diagrammatic section (Pl. XVI. fig. 2), belong to the species, but have been accidentally intruded.

The *dermal skeleton* consists of rough sword-shaped hexact hypodermalia with greatly prolonged proximal rays, and toothed, slightly thickened distals, on which several (frequently four) narrow pointed diacts are disposed, and with their outer extremities extended for a greater or less distance beyond the points of the distal ray (Pl. XVI. fig. 2).

The *gastral membrane* is supported by the transverse rays of the rough pentact-hypogastralia, whose long distal ray penetrates radially into the parenchyma.

The spicules of the basal tuft of fibres consist for the most part of very long diacts, which are smooth on the outer pointed extremities, but are beset further down with barbs, and bear at their inferior extremities a conical pointed knob, from the side of which three or four strong anchor-teeth project outwards and upwards. The intersection of the axial canal lies, as a rule, at some distance from the inferior extremities, and corresponds usually with the four lateral prongs, which are cruciately arranged (Pl. XVI. fig. 11). In some long spicules which run out to points on both ends, I have also found the axial cross of the central canal in the middle, and the hook-like teeth so directed on the two sides that their points were turned away from the centre (Pl. XVI. fig. 12).

The skeleton of the tolerably compact terminal sieve-plates chiefly consists of strong hexacts, which form quadrate meshes by the apposition of the transverse rays. Their distal, freely projecting ray is spindle-shaped, thickened, and sparsely covered with small conical teeth, while the short proximal is a simple cone, and entirely tubercular. (Pl. XVI. fig. 8). The four cruciate, long, transverse rays are smooth, and gradually run out to a point. To these transverse rays, but more especially to the outwardly projecting distal, diacts with pointed extremities are closely affixed (Pl. XVI. fig. 8).

Holascus polejaevii, n. sp. (Pl. XVII. figs. 1–5).

The single, probably young, specimen figured on Pl. XVII. fig. 1, represents a new species of *Holascus*, which I dedicate to the meritorious investigator of the Calcarea and Keratosa, Dr. Poléjaeff. This form was trawled to the south of Australia (Station 157, lat. 53° 55′ S., long. 108° 35′ E.), from a depth of 1950 fathoms, and a bottom of Diatom ooze. The specimen has been injured at the upper end, so that both the terminal sieve-plate and the marginal ridge are wanting.

The sack-shaped, somewhat thin-walled body has a length of 10 mm., and a

breadth of 4 mm. From the narrowed lower end there arises a basal tuft, 4·5 mm. in length.

The spicules, which principally serve for the formation of the quadrate lattice-like network of the parietal skeleton, are simple hexacts with smooth, frequently somewhat bent rays (Pl. XVII. fig. 2), to which some comitalia are here and there apposed. Of loose parenchymalia there are present, in addition to some small regular hexacts, simple thin diacts, and three different kinds of rosettes. Among the latter the well-known oxyhexaster form, with three long, diverging, terminal rays on each of the moderately short principal rays, is most frequent (Pl. XVII. fig. 3); less frequently an oxyhexaster occurs, from each of whose strong principal rays, which are expanded outwardly in petaloid fashion, a bundle of eight or more strong, straight, moderately diverging, terminal rays proceeds (Pl. XVII. fig. 4). Graphiohexasters only occur scattered through the outer region of the parenchyma, and are provided with long bundles of fine, slightly diverging, terminal rays (Pl. XVII. fig. 2).

The sword-shaped hypodermalia have a long, often somewhat bent, proximal ray, a slightly thickened, scaly, pronged distal ray, and four simple, smooth, pointed, transverse tangential rays. Close to the proximal and distal rays, narrow diacts occur here and there which run to a point on both ends, and exhibit central thickened knots. As in the other species of *Holascus,* these diacts extend for a considerable distance beyond the extremity of the hypodermalia (Pl. XVII. fig. 5).

The hypogastralia are simple pentacts whose long distal ray may be applied to the corresponding proximal ray of a principal hexact or of one of the hypodermalia (Pl. XVII. fig. 2).

Of the basalia only the upper part is preserved, and this does not differ essentially from that of the basalia of *Holascus fibulatus.*

4. *Holascus ridleyi,* n. sp. (Pl. XVII. figs. 6–8).

In the neighbourhood of the Philippines (Station 211, lat. 8° 0′ N., long. 121° 42′ E.). the dredge brought up from a blue mud ground, and a depth of 2225 fathoms, a portion (about 5 cm. long, and 2 cm. broad) of the lateral wall of a *Holascus,* the siliceous spicules of which though agreeing indeed in some points with those of *Holascus polejaevii,* are so markedly different in others that it must be described as a distinct species. I shall name this after Mr. Stuart O. Ridley, the meritorious investigator of the Challenger Monactellida.

The principal skeletal framework consists of substantial, long, smooth-rayed tetracts, forming the quadrate meshes of the side wall, and, closely apposed to the latter, delicate comitalia with a variable number of rays (Pl. XVII. fig. 6).

The intersections of the longitudinal and of the transverse bands of fibres, which lie more towards the interior, do not all contain the axial cross of a principal tetract. In

fact, intersections with and without such a cross alternate quite regularly both in the longitudinal and transverse direction.

The parenchyma is richly provided with oxyhexasters, each of the principal rays of which bears four or three straight diverging terminals (Pl. XVII. fig. 8). Here and there I also found an oxyhexaster form with much curved terminal rays (Pl. XVII. fig. 7), though it remains doubtful whether this type really belongs to the sponge. On the other hand, more frequently, and undoubtedly belonging to the sponge, characteristic hexact spicules occur which, like those of *Holascus polejaevii* represented in Pl. XVII. fig. 4, bear on each of the strong principal rays (which are widened and petaloid towards the exterior) a bundle of eight or more markedly diverging terminals. The terminal expansion of the principal rays is even larger, and more sharply separated from the inner portion than in the above-mentioned species.

The hypodermalia resemble those of *Holascus polejaevii*, and are, like the latter, extended outwards by the longer apposed, thin, pointed diacts.

The hypogastralia on the other hand are not pentacts but slender hexacts, in which the somewhat swollen proximal ray, projecting freely inwards into the gastral cavity, is beset with small prongs.

Genus 2. *Malacosaccus*, n. gen. (Pls. XVIII., XIX.).

These sponges are saccular or tubular forms, with a flabby readily pliable wall, whose outer surface appears uniformly even, while on the inner surface numerous, larger or smaller, round openings of the efferent passages occur in irregular distribution. The inferior extremity has not been observed, but the superior exhibits a wide opening surrounded by a narrow smooth margin.

The principalia are represented by hexacts with long, thin, flexible rays, which are disposed in radial, longitudinal, and transverse directions, becoming apposed to one another, and partly interwoven to form a cubical lattice-work. Oxyhexasters and discohexasters also occur in the parenchyma.

On the projecting rays of the sword-shaped hexact hypodermalia and hypogastralia, floricomes occur. The epidermal floricomes are larger and stronger than the epigastral.

1. *Malacosaccus vastus*, n. sp. (Pl. XVIII.).

In the south of the Indian Ocean, at a locality about halfway between the Cape of Good Hope and Kerguelen (Station 146, lat. 46° 46′ S., long. 45° 31′ E.), there was trawled, from a depth of 1375 fathoms, and from a bottom of Globigerina ooze, a flabby plate which could be folded like a woollen cloth. Some fragments belonging to the

same form were also obtained. Three sides of this irregularly quadrangular plate, which measured about 1 foot square, exhibited much torn margins, but on the fourth the natural border was preserved. On the very probable supposition that this border, which is about 40 cm. in length, represents the upper margin of the sponge, and that no great portion is wanting, the whole form would be that of a sack or cup, whose upper aperture would be about 13 cm. in diameter. At the much destroyed margin, opposite to the intact border, and, therefore, probably the lower, the sponge is as much as 1 cm. in thickness, and decreases gradually from this point to the upper somewhat sharp margin. In order to convey an idea of the character of the outer and inner surfaces I have figured a portion from the middle in its folded position (Pl. XVIII. fig. 1). While the outer surface appears uniformly flat, and merely exhibits numerous subdermal cavities of varied size, the inner surface bears numerous round excurrent orifices belonging to the efferent passages, and varying from 3 to 12 mm. in diameter. These are irregularly distributed, at intervals of 5 to 15 mm., and show at the bottom that they are ramified. Between these wide excurrent orifices a comparatively flat surface is seen, only perforated here and there by small apertures.

The principalia forming the supporting framework of the entire sponge are hexacts with long smooth and flexible rays,[1] which are accompanied by long, thin, and very flexible comitalia. The parenchyma also contains numerous hexacts, of median size, with tubercled rays, further small hexacts with smooth rays, and finally rosettes of two kinds. Among the latter the oxyhexasters, which are present in great abundance, first attract attention. They bear on each of their short principal rays, which are somewhat expanded outwardly, four long narrow terminals (Pl. XVIII. fig. 10). The second form of rosette, which belongs to the discohexaster type, is smaller, and bears, on the gently convex transverse terminal disc of each principal ray, a bundle of about thirty delicate terminals which become broader towards the outer extremities, and which are beset laterally with numerous small barbs, and provided terminally with a four-pronged transverse disc (Pl. XVIII. figs. 3, 5).

The hypodermalia of the dermal skeleton have a slightly spindle-like thickened distal ray with scaly teeth, a long smooth proximal which runs to a point, and four simple, smooth pointed, transverse rays (Pl. XVIII. figs. 2, 8). Whether the large and strongly-developed floricomes which occur very abundantly scattered on the outer surface in many regions (Pl. XVIII. fig. 4), are regularly attached to the distal rays of the hypodermalia, as in the Euplectellinæ, I cannot definitely assert, since I have not found them in this position. It is, however, quite possible that, on account of the great softness of the whole plate, they have been pushed out of their original position.

The hypogastralia are likewise hexacts with a prolonged parenchymal ray, but the freely projecting proximal is not thickened into a spindle, nor scaly and pronged, like

[1] In Pl. XVIII. fig. 2, the rays of these hexacts are represented much too short and too straight.

the projecting distal of the hypodermalia. All the hypogastralia are somewhat uniformly rough. It has not been determined with certainty whether the numerous floricomes which are represented on Pl. XVIII. figs. 6, 7, 9, and which appear abundantly on certain portions of the inner surface, really adhere to the projecting proximals of the hypogastralia. These inner floricomes differ from the outer, moreover, not only in their smaller size, but also in the fact that the slightly bent terminals, which occur to the number of six or more on every principal ray, bear small barbs in addition to the many pronged terminal plate (Pl. XVIII. figs. 6, 7).

2. *Malacosaccus unguiculatus*, n. sp. (Pl. XIX.).

To the south of Sierra Leone (Station 348, lat. 3° 10′ N., long. 14° 51′ W.) there was collected from a depth of 2450 fathoms, and on grey mud, a saccular sponge, 3 cm. in length and 1·5 cm. in breadth, with walls measuring from 1 to 2 mm. in thickness. The inferior extremity was torn off, and the superior margin only preserved in an injured condition. The outer surface is slightly rough, but on the whole uniformly even, while the inner surface, on the other hand, is perforated by numerous canalicular orifices of varied breadth (Pl. XIX. fig. 1).

The principalia of the parenchymal skeleton are represented by slender hexacts with long, narrow, smooth and flexible rays, which are disposed radially, longitudinally and transversely, and apply themselves by corresponding rays to one another, or to the prolonged parenchymals of the hypodermalia and hypogastralia, so as to form a loose network which permits of the bending and folding of the whole sponge-wall. The parenchyma also includes numerous oxyhexasters with slender, straight, or slightly bent terminal rays, of which three occur in most cases on each of the comparatively short principals (Pl. XIX. fig. 7). Delicate discohexasters also occur, with thin terminal rays which are somewhat thickened outwardly, and which bear upon their outer extremities a whorl of four or more backwardly bent, thin, transverse spines (Pl. XIX. fig. 3).

The hexact hypodermalia have a thickened distal ray beset with scaly teeth, and a greatly prolonged proximal, which, like the moderately long transverse rays, is seldom quite smooth, but is, as a rule, more or less richly beset with small pronged elevations (Pl. XIX. figs. 2, 4).

The hypogastralia are very similar to, but are distinctly more slender than the hypodermalia (Pl. XIX. fig. 2).

Floricomes are not found on the outer surface but appear here and there on the inner. They bear three or four terminals on every principal ray. The thickened outer extremity of every terminal ray runs out into an overhanging plate with two or three strong terminal claws (Pl. XIX. figs. 5, 6).

Although I did not find these floricomes upon the inwardly projecting proximal ray of

the hypogastralia, but here and there even beneath the gastral membrane, I am still inclined to believe that here too they have been inserted on the tips of the hypogastral spicules.

Subfamily 3. Tægerinæ, F. E. Schulze (Pls. VII.–XI.).

The wall of the saccular or tubular body is perforated by apertures of various sizes, irregular in shape and arrangement. The lattice-like trabeculæ of the skeleton form for the most part an irregular network of partially cemented principal spicules. The outer end of the distal ray of each dagger-shaped hypodermal hexaster bears a floricome.

Genus 1. *Tægeria*, n. gen.

Tægeria pulchra, n. sp. (Pl. VII.; Pl. VIII.; Pl. XI. figs. 1–3).

In the neighbourhood of the Fiji Island, Kandavu (Station 174c, lat. 19° 7′ 50″ S., long. 178° 19′ 35″ E.), the trawl brought up, from a depth of 610 fathoms, on a bottom of coral mud, an elegant Euplectellid, which is figured on Pl. VII., after the restoration made by Wyville Thomson from a somewhat damaged specimen.

The thin-walled saccular body, which expands somewhat above the middle to a maximum diameter of 6·5 cm., exhibits a circular section, and has a length of 20 cm. Near the lower blind sack-like end there is a compact, tangled, somewhat lateral, basal prolongation which grows on the firm substratum. The upper extremity bears a circular opening, 3 cm. in diameter, which is surrounded by a somewhat firm margin, and overarched by a beautiful corona of long, curved, siliceous spicules which bend towards the centre. The lateral wall of the body is only from 2 to 3 mm. in thickness, and is penetrated by numerous irregularly scattered, approximately circular, tolerably large parietal apertures, varying from 3 to 4 mm. in diameter. These gaps are disposed at intervals of from 1 to 2 cm. in the median portion of the sponge, but are, above and below, somewhat more widely apart. Between these larger orifices, smaller round pores here and there occur, varying from 1 to 2 mm. in diameter. The numerous, light, roundish spots, however, which may be observed in the spirit specimen, and also in the figure on Pl. VII., occurring on the external surface between the above noted apertures, are neither holes nor pits from the outside, but represent pit-like hollowings on the inner surface which do indeed in many cases become, at a later period, artificially opened and converted into canals which pass completely through the wall.

The larger beams of the supporting skeletal framework, together with the delicate comitalia which surround them, are for the most part fused, by cementing matter

and synapticula (Pl. VIII. fig. 6), into a continuous network, which seems to be firmest on the inferior portion of the sack, becoming more and more loose towards the upper end. While the principal strands of fibres are irregularly disposed, for the most part obliquely, on the inferior and middle thirds of the body, the upper third exhibits a more regular arrangement of the longitudinal beams and circular transverse ridges.

The latter lie, as in all Euplectellidæ, on the inner side of the former. The strong principalia of the lattice-work are in the regular upper portion almost exclusively tetracts, in the larger and more irregular inferior portion, on the other hand, triacts and diacts predominate. The comitalia consist chiefly of triacts and diacts.

Closely disposed spicules, with from six to two rays, also occur in the parenchyma, viz., somewhat numerous, small, smooth or spinose, regular hexacts, with rays running out to fine points (Pl. XI. fig. 2); more rarely small, smooth discohexacts (0·17 mm. in diameter), with from four to six hooks on the arched terminal discs, and finally, discohexasters irregularly scattered in somewhat large numbers (Pl. XI. fig. 1; Pl. VIII. fig. 4). Most of these discohexasters exhibit the same characters and dimensions as the discohexacts, which have just been mentioned. The very short principal rays usually run out into two, less frequently into three, long terminal rays, which are, at their origin, united in a bow-like manner, and which, narrowing in the middle, again increase in strength towards the terminal hemispherical disc, which bears six strong hooks (Pl. VIII. fig. 4). Hexasters with somewhat longer and narrower terminal rays occur scattered at intervals, and on their transversely truncated extremities, four to six small hooks project transversely. In the neighbourhood of the outer surface graphiohexasters occur with long tufts of parallel, straight, very delicate, terminal rays (Pl. VIII. fig. 5).

The sword-like hexact hypodermalia are delicate, and run out to fine points. To their distal ray a floricome is always attached, which does not differ essentially from the well-known floricome of *Euplectella aspergillum* (Pl. VIII. fig. 3).

The gastral skeleton consists of somewhat stronger pentacts, in which both the prolonged distal and the four tangentials are either transversely rounded off, or terminate in a knob-like swelling (Pl. VIII. fig. 7).

The thickened margin which surrounds the upper terminal opening bears two circularly arranged rows of hexacts with strongly developed distal rays. In the spicules of the outer circle the straight distals, which measure from 2 to 3 mm. in length, are directed obliquely outwards and upwards, while the slightly bent, strong, distal rays of the inner circle, which are $1\frac{1}{2}$ cm. in length, bend together in dome-like fashion over the opening, so that only a central space, about 8 mm. in breadth, remains (Pl. VII.).

The folded layer of simple sacciform chambers surrounds clefts or short canals, which either open freely by wide internal openings, or are arched over by a continuation of the gastral skin (Pl. XI. fig. 1). The inner trabecular framework occurs in a thin layer on the inner side of the efferent passages which lead from the wide openings of the

chambers, while the outer trabecular framework either entirely fills the space between the chambers and the outer skin, or is perforated by the subdermal lacunæ and afferent canals.

The name of the genus *Tægeria* is formed from the family name of my wife, "Tæger."

Genus 2. *Walteria*, n. gen.

Walteria flemmingii, n. sp. (Pl. IX.; Pl. X.; Pl. XI. figs. 4–6).

The fragment of a hitherto unknown Hexactinellid, which is very faithfully represented in its natural size on Pl. IX., was collected in the Pacific to the north of the Kermadec Islands (Station 170A, lat. 29° 45′ S., long. 178° 11′ W.), from a depth of 630 fathoms, on volcanic mud. The sponge appears to be broken across the middle, and to have had about double the length of the fragment preserved, which is 15 cm. long by 8 cm. broad, becoming narrowed towards its extremity into a conical funnel-shaped tube only 6 mm. in width. Since the terminal portion is also broken off at this place it is impossible to determine whether we have before us the inferior extremity by which the sponge was fixed or the free upper end.

The thin wall of the tube consists of a framework with strands of varied strength, seldom more than 1 mm. in thickness, and surrounding polygonal meshes of very diverse size and irregular form, which may attain the size of 1 cm. It is only towards the narrowed funnel-like end that the strands arrange themselves in a system of somewhat converging longitudinal and transverse bands of fibres, which come to lie closer and closer to one another, forming quadrangular meshes, which are only crossed by small secondary beams. Here and there in the expanded main portion of the sponge longitudinal and transverse beams may also be recognised. Most of the beams in the lattice-like network are not smooth, but are beset with small knobs which project externally, and which occur sometimes isolated, sometimes in grouped arrangement. Even on examination with the naked eye, but more obviously by employing a lens or the microscope, the network strands may be seen to be supported by a firmly united siliceous framework, which is covered by a distinct and strongly-developed soft skin. The latter becomes elevated into numerous small short tubes which project obliquely or at right angles to the surface, and are each tenanted by the hydranth of a commensal hydroid polype. While the hydrophyton extends into the deeper layer of the rind, the shortly-stalked or sessile hydranths project transversely outwards (Pl. XI. fig. 4). There can be no doubt that the hydranth, by its simple presence and especially by the continual stimulus exercised on the surrounding sponge substance by its expansion and contraction, has caused the formation of the projecting tubes. I have not observed anything of the nature of a perisarc. The hydroids seem to be entirely naked, and lie

in simple lacunæ, which are, for the most part, formed by a rupture of the inner trabecular framework. Wherever a hydranth arises, the chamber layer, the outer trabecular framework, and the outer wall, become perforated by a canal opening to the exterior.

The chamber layer is but slightly folded, a circumstance which is in harmony with the slight thickness of the whole body-wall.

The principal lattice-like framework of the skeleton consists of long compact spicules with a varied number of rays, but especially triacts and diacts, which, with the more delicate comitalia that surround them, are, for the most part, disposed in bundles, and firmly united by means of numerous synapticula (Pl. X. figs. 3, 6). The circular beams lie as before on the inner side of the longitudinal, while the oblique strands are irregularly interwoven throughout the entire lattice-work. In the narrowed funnel-shaped terminal portion of the sponge the spicules of the framework are more delicate, shorter, and more amalgamated.

The looser parenchymalia are in part extended spicules among which diacts seem to predominate, which are provided with conical or rounded rough extremities, and in part small delicate hexacts with fine transverse prickles, and lastly rosettes of two kinds. The one type includes discohexasters with few, usually three, long terminal rays on each of the six short principals. Where the principal ray divides an irregular tubercular thickening occurs, and from this the somewhat distant, narrow, diverging terminals which separate from one another project outwardly, while the extreme ends bear small discs with from four to six transversely disposed, inwardly bent, thin hooks or claws (Pl. X. fig. 5).

The other rosettes are, it is true, likewise discohexasters, but they may be distinguished from those just described in different respects.

The entire appearance is essentially different since, besides the stellate, the spherical form also prevails (Pl. X. fig. 1 ; Pl. XI. fig. 4), on account of the great number of equally long terminal rays which bear hemispherical transverse terminal discs. Each of the six short principal rays passes at first into a discoid expansion, which bears on its arched outer surface numerous (about thirty) terminals, which increase somewhat in strength towards the exterior, and are disposed in a radiating and divergent fashion. The hemispherical terminal discs of these terminal rays have a sharp-pronged margin which extends inwards in a somewhat campanulate manner. In some cases the number of the terminal rays on these rosettes is less, each principal ray bearing only about seven terminals. It is noteworthy that the rosettes, which have on the whole a spherical appearance, and are provided with hemispherical terminal discs, always occur only in the neighbourhood of the outer skin (Pl. XI. fig. 4), whereas the stellate forms which are provided with transversely disposed terminal tubercles are, on the other hand, scattered throughout the whole parenchyma.

Whether the bundles of very fine rhaphide-like spicules, which I found here and there in the parenchyma in the neighbourhood of the outer surface, are to be regarded as the broken off terminal rays of graphiohexasters or as independent groups of spicules, I cannot

with certainty determine, since I was never able to find a completely intact graphiohexaster. I am, however, inclined to the former opinion, since I have always found a number of these rhaphide bundles together, and in the neighbourhood usually a small six-rayed cross, with a discoid expansion of the cylindrical principal rays, from which numerous small points projected like the broken ends of fine terminal rays. The whole exactly resembled the middle portion of a graphiohexaster whose terminal rays had been broken off.

The sword-like hexacts of the dermal skeleton are distinguished by the strength of the four tangential and of the distal rays, all of which terminate in rounded off extremities, while the prolonged proximal gradually decreases in diameter towards the extremity, and finally terminates in a conical point. The distal ray corresponding to the hilt of the sword bears, sometimes in the middle or towards the outer extremity, a club-like thickening (Pl. XI. fig. 6).

On the distal ray of most of the hypodermalia a floricome occurs, which is distinguished from those of *Euplectella aspergillum* by the greater number (fifteen) of the S-like curved terminal rays on each principal, and by the wider cup-like form of each whorl of terminals (Pl. X. fig. 2).

A special gastral skeleton is always absent where the large beams of the lattice-work directly form the inner wall. Where this is not the case, it consists of simple hypogastral pentacts, with four equally long intersecting rays, lying on the parenchymal side of the gastral membrane, while the prolonged unpaired fifth ray penetrates widely into the parenchyma (Pl. XI. fig. 2).

The extremities of all the five rays are simply rounded or slightly knobbed and thickened, only the prolonged distal is sometimes narrowed towards the extremity, and may even terminate in a point.

I have named this memorable sponge in honour of my esteemed friend and colleague Professor Walter Flemming of Kiel.

Since the single and much damaged specimen of *Walteria flemmingii* is inhabited by many comparatively large commensal hydroid polypes, which have doubtless produced the peculiar tubules running obliquely or at right angles to the peripheral strands (Pl. X. figs. 4, 6; Pl. XI. fig. 4), the question arises whether we have here to do with a *normally* formed individual, or not rather with one essentially modified. In specimens without these invading polypes, the wide lumen of the parietal gaps may be in great part filled up by the soft portion of the body-wall, which is here restricted almost exclusively to a cortical layer for the supporting beams.

I know of at least one case in another group of sponges, namely, that of a *Myxilla*, found abundantly near Trieste, which is normally a compact bulbous body, but which when invaded by *Stephoscyphus mirabilis* becomes bush-like, resembling a tuft of the common heath *Calluna vulgaris*.

The following seven genera are not yet sufficiently known to enable their systematic position to be determined, but they all appear to belong to the family Euplectellidæ, and hence are treated of here.

Genus 1. *Habrodictyum*, Wyville Thomson.

This genus contains only one species, *Habrodictyum speciosum*.

Habrodictyum speciosum (Quoy and Gaimard).

1833. Quoy and Gaimard, Voyage de l'Astrolabe, Zool., vol. iv. p. 302.
1836. Deshayes and Milne-Edwards in Lamarck, Animaux sans Vertèbres, vol. ii. p. 586.
1849. Owen, Trans. Zool. Soc. Lond., vol. iii. p. 205.
1865. Bowerbank, British Spongiadæ, vol. i. p. 174.
1866. Gray, Ann. and Mag. Nat. Hist., ser. 3, vol. xviii. p. 487.
1867. Gray, Proc. Zool. Soc. Lond., 1867, p. 530, 531.
1868. Wyville Thomson, Ann. and Mag. Nat. Hist., ser. 4, vol. i. p. 114.
1869. Bowerbank, Proc. Zool. Soc. Lond., 1869, p. 323.
1872. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. ix. p. 442.
1873. Carter, *Op. cit.*, ser. 4, vol. xii. p. 349.
1873. Gray, *Op. cit.*, ser. 4, vol. xiii. p. 284.

Quoy and Gaimard[1] gave a description and figure of a form designated *Alcyoncellum speciosum* which differed essentially from any sponge then known. The genus *Alcyoncellum* had been some years before, 1830, defined by Blainville[2] in the following manner :—"Corps fixé, mou, subgélatineux, solidifié par des spicules tricuspidés, phytoide, à branches peu nombreuses, cylindriques, fistulaires, terminées par un orifice arrondi, à parois épaisses, composées de granules réguliers, polygones alvéoliformes, percés d'un pore à l'extérieure et à l'intérieure."

The generic definition is followed by this note[3] :—"Espèce L'alcyoncelle spécieux, A. speciosum, Quoy et Gaimard, Zoologie, Astrolabe, msc." As the following "observation" adds :—"Ce genre a été établi par Mm. Quoy et Gaimard pour un corps organisé, rapporté dans leur dernier voyage et qu'ils ont bien voulu soumettre à notre observation. Quoique sa forme rappèle un peu celles des cellaires, il est cependant évident, que c'est auprès des alcyons et des éponges, qu'il doit être placé. Mais ensuite, pour déterminer, si c'est un alcyon proprement dit ou un Spongiaire, il faudrait savoir, si chaque grain celluliforme contient un polype ; toutefois, comme cela nous paraît peu probable, nous nous sommes déterminé à en faire un faux alcyon ou un spongiaire."

The description of *Alcyoncellum speciosum*, Quoy and Gaimard, is, on the other hand, just as published in 1833 by Quoy and Gaimard,[4] for the genus (*Alcyoncellum*) :—

[1] Voyage de la Corvette l'Astrolabe, Zool., 1883, vol. iv. p. 302–303, and Atlas, vol. ii., Zoophytes, pl. xxvi. fig. 3.
[2] Dict. d. Sci. Nat., vol. lx. p. 492.
[3] Blainville, *loc. cit.*, p. 492.
[4] Voyage de l'Astrolabe, Zool., p. 302.

"Spongiaire, lamelleux, dont la charpente est formée de filets très déliés, accolés les uns aux autres et entrecroisés de manière à former des mailles nombreuses, arrondies, assez régulières et semblables à celles d'une dentelle," and for the species (*Alcyoncellum speciosum*):—"Alcyoncellum cylindricum, cavum extremitate rotundum, album, reticulis lapidicis elegantissime contextum." "Cette singulière production donnant lieu au genre ci-dessus représente un cylindre creux de sept à huit pouces d'étendue, en forme, de phallus, arrondi et un peu dilaté à une extrémité, ouvert á l'autre, à parois minces, formées de filets très déliés, lâchement accolés les uns aux autres, entrecroisés dans tous les sens de manière à former des nombreuses mailles arrondies, presque regulières comme celles de la dentelle ou bien des sièges tissés en rotang. Ce qui fait, que tout la masse est à jour. En voyant l'élégante blancheur et la régularité d'un tel tissu, on a de la peine à se persuader qu'il est le produit d'une réunion d'animaux. On aime mieux en voir un seul au fond de la mer travailler à se faire ce logement pour un but quelconque, en tirant de sa propre substance, comme le font certaines chenilles, la matière, qui se pétrifié aussitôt qu'elle est en contact avec l'eau. Ce zoophyte habite, nous a-t-on dit, de grandes profondeurs d'où il a été amené par une sonde. Les éclats qu'on remarque à une de ses extrémités indiquent qu'il doit être fixé. Nous le devons à M. Merkus gouverneur des Moluques, qui s'est plu à favoriser avec la plus grande obligeance nos recherches d'histoire naturelle pendant le temps que nous avons passé dans les îles qu'il administre."

In Blainville's work,[1] besides a repetition of the generic diagnosis of *Alcyoncellum* above quoted, which is also contained in the Dict. d. Sci. Nat.,[2] these words also occur:—"Espèce l'Alcyoncelle gélatineux, A. gelatinosum, Quoy et Gaimard," and then there follows the same "observation" which has already been quoted above (p. 99) from the Dict. d. Sci. Nat. But the figures of *Alcyoncellum gelatinosum* which are given by Blainville[3] undoubtedly represent *a calcareous sponge* belonging to the family of Sycones (Haeckel).

In the second volume of Lamarck's Histoire naturelle des animaux sans vertèbres, which appeared in 1836, Milne-Edwards stated the characters of the genus *Alcyoncellum* in the following words:—"Spongiaire lamelleux, dont la charpente est formée de filets très déliés, accolés les uns aux autres et entrecroisés de manière à former des mailles nombreuses arrondies, assez regulières, et semblables à celles d'une dentelle." In this he evidently refers exclusively to that siliceous skeleton which Quoy and Gaimard had figured and described as *Alcyoncellum speciosum*, without even mentioning the older species *Alcyoncellum gelatinosum*, Blainville.

While Max Schultze, Bowerbank and Gray, as already mentioned, regarded *Alcyoncellum speciosum*, Quoy and Gaimard, as identical with *Euplectella aspergillum*, Owen,

[1] Manuel d'Actinologie, 1834.
[2] Vol. lx. pp. 492, 529.
[3] Manuel d'Actinologie, Atlas, pl. xcii. fig. 5.

and while Bowerbank included in his genus *Alcyoncellum,* in addition to the well-known species *Alcyoncellum aspergillum,* the two species designated *Alcyoncellum corbicula* and *Alcyoncellum robustum,* Gray separated the genus *Alcyoncellum* from *Euplectella,* and divided it into two genera, *Corbitella* and *Heterotella.*

Corbitella, which included the single species (figured) *Corbitella speciosa,* was characterised thus :—"The tube clavate, rather irregular, rounded at the end, formed of slender fascicules of open elongate filiform spicules, placed in longitudinal transverse and oblique directions, forming an irregular network ;" the genus *Heterotella,* on the other hand, with the single species *Heterotella corbicula,* is defined as follows :—"The tube short, rather irregular, conical, truncated, irregularly netted. Skeleton formed of thick bundles of very numerous slender spicules, placed in all directions, and forming an irregular network, similar to the network of the lid of *Euplectella.*"

Soon after this, however, Wyville Thomson, in his renowned contribution On the Vitreous Sponges,[1] again united the two genera of Gray, *Corbitella* and *Heterotella,* into one, on account of the great similarity of their form, structure, and siliceous spicules, and named the genus *Habrodictyon.* His characters for this new genus are as follows :[2]—"Sponge body subcylindrical, tubular, attached by a slightly contracted base. The walls of the tube composed of a perfectly irregular network of bundles of siliceous needles loosely and irregularly arranged in sheaves crossing one another at low angles, and connected by a small quantity of soft mucilaginous sarcode. The spicules of the skeleton all essentially of the hexradiate form, free and separate from one another, or rarely connected in groups of two or three. The spicules of the sarcode numerous 'floricomo-hexradiate stellate,' and various simple and branched modifications of the hexradiate type." The two forms *Habrodictyon speciosum* and *Habrodictyon corbicula* were examined afresh in respect at least to the skeletons which had already been studied by Bowerbank and Gray, and which are preserved in the Museum of the Jardin des Plantes in Paris. One of these which bears the museum label "*Alcyoncellum corbicula,* Valencienne, donné par M. Saches 1857," and which was named *Heterotella corbicula* by Gray, exhibits a beaker-like inferiorly anchored tube, 10 cm. in height and 5 cm. broad in the superior part, while its terminal opening is closed by a transverse sieve-plate. The lateral wall of the tube consists of a very irregular network in which the beams form irregular, roundish meshes, and are composed of loosely united rod-like spicules varying in length up to 15 mm. No definite arrangement of the beams of the network in transverse and longitudinal bands is exhibited, nor is there any indication of externally projecting ridges.

While the long rod-like spicules, which are somewhat thickened and rough at both ends, merely exhibit in the middle four cruciately disposed lateral tubercles, as indications of the six-rayed type, numerous well-developed six-rayed spicules also occur, which are,

[1] *Ann. and Mag. Nat. Hist.,* ser. 4, vol. i. p. 114, 1868. [2] *Loc. cit,* p. 126.

in part, quite regularly formed with six long, smooth, conical rays, and in part more irregularly with bent and knotted rays. Wyville Thomson describes as peculiar "flesh spicules" the small regular hexradiate forms which cover the skeletal framework and are abundantly scattered throughout the soft parts, and also the elegant structures which were termed "floricomo-hexradiate stellate" by Bowerbank, in which each of the six principal rays is continued into a small, outwardly curved, richly pronged, terminal plate, and into a petaloid system of small branches which are bent in an S-shaped manner, and widened at their extremities. The network of fibres forming the terminal sieve-plate, which extends all round the sharply truncated lip-like upper walls of the tube, consists of the very same elements as the wall of the tube, but appears more closely woven, and exhibits large six-rayed spicules between the rod-like forms, which are in general somewhat short. Besides this completely preserved skeleton, which has been figured by Wyville Thomson from a photograph, the Museum of the Jardin des Plantes in Paris is said to contain a second injured specimen and a fragment of a third.

As to the other form, designated by Gray *Corbitella speciosa—Habrodictyum speciosum*, Quoy and Gaimard—Wyville Thomson was able to study only the single specimen contained in the Museum of the Jardin des Plantes, and labelled '*Alcyoncellum corbicula* Val. tiré par 80 brasses de profondeur dans la rade de St. Denis de Bourbon par M. Leschenault 1819." This is probably[1] identical with the specimen first described and figured as *Alcyoncellum speciosum* by Quoy and Gaimard in their great work. It exhibits a lattice-like tube 19 cm. long, which gradually widens from a base which, when fully grown, is 32 mm. broad, to a free upper extremity which is 60 mm. in breadth. The lateral wall of the tube does not, as in *Heterotella corbicula*, end in a sharply truncated upper margin, nor become closed by a flat transverse sieve-plate, but, without changing in texture, bends inwards, and so forms a curved arch which serves to close the tube above. While the rod and spindle-like spicules which compose the lattice-like framework, and also the larger six-rayed spicules, resemble the corresponding elements of the other species except in a few differences in size, and while both the above-mentioned small, stellate six-rayed forms and "floricomo-hexradiate stellate spicules" recur in similar form and size scattered through the soft body, there is further a very abundant occurrence of a flesh spicule, which has not been certainly observed in *Habrodictyum corbicula*, namely, a small hexradiate form with its branches divided longitudinally in a forked or trifid manner. It was the great abundance of this form, which Bowerbank termed a "bifurcate rectangulated hexradiate spicule," which mainly induced Wyville Thomson to regard *Habrodictyum speciosum*, Quoy and Gaimard, in every

[1] The circumstance already recorded by Gray (*Ann. and Mag. Nat. Hist.*, ser. 4, vol. i. p. 173) is striking, and one by no means easy to reconcile with the above supposition, namely, that in the Voyage de l'Astrolabe Quoy and Gaimard note that their specimen was presented to them by Mr. Merkus, governor of the Moluccas. In order to reconcile the two statements it must be accepted that the elegant form which Mr. Merkus presented did not come from the Moluccas, but from the Isle of Bourbon.

other respect closely related to *Habrodictyum corbicula*, as a quite distinct and separate genus from the latter, and further, the fact that in *Habrodictyum speciosum* no terminal sieve-plate is present, led Wyville Thomson to object to the opinion which had been expressed by Bowerbank,[1] to the effect that in *Euplectella* and allied sponges "the openings of the lid and those of the tube stand to one another in the relation of oscula and pores." He maintains that on the contrary "each of the large openings of the wall is occupied by an exhalent orifice and that inhalation takes place as usual by minute pores in the interstices between the spicules of the skeleton."

Carter says in his treatise On Hexactinellidæ,[2] "*Alcyonellum speciosum* and *Alcyonellum corbicula* appear to me to belong to one and the same species," which opinion I assent to.

The genus *Habrodictyum* probably also includes *Eudictyum elegans*, Marshall, which Marshall has briefly described from a hollow, canal-like form (preserved in the Museum of the Amsterdam Zoological Garden), agreeing with *Habrodictyum speciosum*, Quoy and Gaimard, in the form and structure of its irregular, lattice-like skeleton, though exhibiting in the interior a looser spicular work (of interstitial connective tissue—Flockengewebe). The latter consists, according to Marshall, chiefly of long (up to 1 cm.) rod-like spicules, between which slender, sword-shaped hexradiate forms occur, besides more delicate six-rayed and five-rayed spicules, with irregularly developed prickles, and further, small crowded forms, with six, five, four or three rays, which, like the two-rayed so-called compass spicules, probably form wreaths round the dermal ostia. Particularly characteristic are the six-rayed spicules, 0·2 to 0·3 mm. in axial length, which bear on the extremity of each ray a disc with seven prongs. Marshall's bristle-like spicules also occur, as well as the well-known "floricomo-hexradiate rosettes," which do not differ essentially from those of *Euplectella*.

In the memoir which appeared in 1876,[3] Marshall characterised the family of the Euplectellidæ as follows:—"Pollakid Hexactinellidæ of tubular form, monozoic, osculum closed by a sieve-plate; in the parietal tissue longitudinal, circular and spiral bundles. Dermal skeleton chiefly formed of hexradiate spicules, between which lie the smaller dermal pores. Large crateriform elevations of the parietal tissue also occur. There are also a considerable number of dermal ostia which lead directly into the body cavity, and which may be closed by compass spicules. The rosettes belong to the 'floricomo-hexradiate' type."

In the genus *Euplectella*, Marshall notes two species, namely, *Euplectella aspergillum*, Owen, and *Euplectella oweni*, Marshall and Herklots, and in the genus *Habrodictyum*, Wyville Thomson, only the single species *Habrodictyum speciosum*, Quoy and Gaimard, leaving it undecided whether the sponge (*Eudictyum elegans*) he had described, from the Amsterdam Museum, is an independent form, or belongs to the *Habrodictyum speciosum*.

[1] British Spongiadæ, vol. i. pp. 176, 177.

[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p 368.

[3] Ueber die Verwandtschaftsverhältnisse der Hexactinelliden, *Zeitschr. f. wiss. Zool.*, Bd. xxvii. p. 128.

Although I have no specimens of this genus *Habrodictyum* for special examination, it follows from Wyville Thomson's above quoted (p. 101) generic diagnosis and figures[1] that the two species distinguished by Wyville Thomson, *Habrodictyum corbicula*, Valenciennes, and *Habrodictyum speciosum*, Quoy and Gaimard, are very closely related to *Regadrella phœnix*, Oscar Schmidt. Whether the agreement goes so far that the two species must be included in a common group I cannot decide, though I regard this as by no means improbable. Wyville Thomson was certainly right in uniting Gray's two genera *Heterotella* and *Corbitella*, and in entirely dropping the generic name *Alcyoncellum*, which really referred to a calcareous sponge.

Habrodictyum agrees with *Regadrella* in this, that the skeletal framework of the tube-wall is formed of an irregular network of fibrous bundles, which in the upper part are only united by means of the soft parts of the body, but which towards the somewhat diminished inferior extremity become gradually more and more firmly welded together by siliceous matter, and finally pass into a knotted base which grows directly upon the solid substratum. The irregular distribution of the parietal apertures is characteristic of both genera. The spicules described and in part figured by Wyville Thomson do not, on the whole, differ much from the spicules of *Regadrella*. Only the rosettes, which are scattered throughout the parenchyma, and which in *Regadrella* are provided with a transverse terminal cross belonging to the terminal rays, exhibit in *Habrodictyum speciosum* true oxyhexasters with proportionately long principal rays and shorter pointed terminals.

While in *Habrodictyum corbicula* the wall of the tube is affirmed to be sharply separated from the transversely disposed terminal sieve-plate by a lip-like margin, such a separation is entirely wanting in *Habrodictyum speciosum*, since the lattice-like network of the tube-wall passes directly and without change into the gently arched terminal plate. Whether *Habrodictyum corbicula* contains the parenchymal oxyhexasters which are so abundantly present in *Habrodictyum speciosum*, has not been determined with certainty.

Genus 2. *Eudictyum*, Marshall.

This somewhat doubtful genus contains only a single species, *Eudictyum elegans*.

Eudictyum elegans, Marshall.

In his investigations into the Hexactinellida[2] Marshall has described, under the name *Eudictyum elegans*, a specimen in the Museum of the Amsterdam Zoological Garden, which is perhaps identical with the above-mentioned *Habrodictyum speciosum* of Wyville Thomson, and at any rate, very closely allied to it. According to Marshall the tissue of the wall of the hollow club-shaped sponge shows longitudinal and trans-

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. i. pl. iv.

[2] *Zeitschr. f. wiss. Zool.*, Bd. xxv. p. 211, 1875.

verse bundles, which run irregularly and usually form anastomoses; the dermal ostia are usually irregularly distributed between them. At the upper end is a strongly injured sieve-like plate which is not so distinct from the tissue of the wall as in *Euplectella*. This trabecular network seemed to Marshall to consist of unsoldered spicules. The loose mass of spicules lies on the inner side of the lattice, and consists of uniaxial spicules 1 to 10 mm. long, slender daggers, weak five or six-rayed forms with irregularly developed rays, very small spicules with several rays (three to six), spicules with compressed rays and similarly formed diacts which are like a compass needle. Hexacts with axes, from 0·2 to 0·3 mm. long, which bear at the end of each ray an umbel with seven rays, are especially characteristic. Finally, there were found five-rayed spicules and floricomes which could not be distinguished from those of *Euplectella*.

Genus 3. *Dictyocalyx*, n. gen.

This genus contains only the one species, *Dictyocalyx gracilis*.

Dictyocalyx gracilis, n. sp. (Pl. XII. figs. 1–7).

The framework of siliceous beams, which is shown in its natural size, from a photograph, in Pl. XII. fig. 1, was trawled in the South Pacific (lat. 22° 21′ S., long. 150° 17′ W.) from a depth of 2385 fathoms, and a red clay bottom (Station 281). From a compact conical basis, which has been attached to some solid body by a basal surface of 5 mm. in breadth, and which is narrowed upwards to a diameter of 3 mm., there arises an irregular retiform framework of beams, resulting in a cup-like form, 25 mm. in length, and about 18 mm. in width above. One of the sides appears to have opened inferiorly, and to have been again closed above.

The beams of this framework, where they spring from the massive base, measure from 2 to 3 mm. in thickness, but become thinner upwards by gradual ramification. They consist of greatly prolonged spicules, which vary in the number of their rays, but which are for the most parts diacts, cemented externally in a quite irregular fashion. In the meshy conical basal portion numerous hexacts occur, soldered between the larger beams.

After a more careful examination of the entire specimen I detected in various places, but especially at the points of union of several intersecting beams, small patches of an adherent soft substance which partly covered the beams. Although such insignificant remnants of the soft body were no longer available for sections, it was still possible to detach them in small fragments from the lattice-like framework, and to detect in them a number of isolated spicules, which throw at least some light on the true character and systematic position of the sponge.

In the first place, slender sword-shaped hexacts occur in great numbers. In these both the prolonged ray and the four rectangularly intersecting transversals are smooth, and terminate in a truncated point, while the sixth ray opposite the former is thickened in its middle portion, and beset with outwardly-directed prongs. I am inclined to believe that these sword-shaped hexacts represent the hypodermalia of the dermal skeleton, and that they bore on their distal ray those floricomes which were found here and there, though indeed very much scattered, and which are figured in a fragment in Pl. XII. fig. 7. This floricome form is distinguished by the small number (three to five) of the terminal claws, and by a peculiar median outward bending of each of the six terminal rays borne by each principal.

Four different forms of rosette also occur. In the first place, discohexasters in which each principal bears four terminal rays, slightly bent in an S-like manner; these terminal rays increase in thickness towards the exterior, and bear terminally a large hemispherical terminal plate, with small marginal teeth (Pl. XII. fig. 2). In the second place, discohexasters with four straight terminal rays, each of which bears on its unthickened extremity a deep campanulate terminal disc whose margins are divided into parallel pointed teeth (Pl. XIII. fig. 4); thirdly, discohexasters half the size of the above, in which each of the principal rays bears a bundle of from twenty to thirty thin terminals varying in length, and terminating in small four-pronged transverse discs (Pl. XII. fig. 6); and fourthly, graphiohexasters with a bundle of very fine somewhat diverging rhaphides, which are borne on the discoid terminal expansion of each principal ray (Pl. XII. fig. 5). As somewhat loose parenchymalia, the scattered simple hexacts and diacts with central intersection nodes are to be noted.

The reference of this sponge to the Euplectellidæ, and to a position somewhere in the neighbourhood of *Tægeria*, I base upon the character of the main skeletal framework, and on the great abundance of sword-shaped floricome-bearing hexacts, which doubtless belong to the dermal skeleton.

Perhaps the variety A of Oscar Schmidt's *Rhabdodictyum delicatum*[1] is identical with my *Dictyocalyx gracilis*, as is suggested by the figure,[2] and the short but very apposite description of the framework which Oscar Schmidt has given in the words: "an airy wall arises from a thick pillar-like base." I would also have accepted O. Schmidt's designation for this Hexactinellid, had the name selected by O. Schmidt appeared to me to be more suitable for his variety B, to which his description (especially of a peculiar rosette) chiefly refers. This variety B is likewise included in the Challenger material, and will be immediately described.

[1] Spongien des Meerbusens von Mexico, p. 46.

[2] *Loc. cit.*, pl. vii. fig 3*a*.

Genus 4. *Rhabdodictyum*, O. Schmidt.

This genus contains only one species.

Rhabdodictyum delicatum, O. Schmidt (Pl. XX.).

Of the two Hexactinellids (dredged in the neighbourhood of Bequia from a depth of 1591 fathoms) which Oscar Schmidt has distinguished as varieties of one species—*Rhabdodictyum delicatum*—it appears to me, as already mentioned, that the variety A is identical with my *Dictyocalyx gracilis*. For the variety B I retain the original name. O. Schmidt describes this latter form as a " simple or branched tube with a perforated wall, formed of interwoven cords. The cords consist of amalgamated or loosely fused hexradiate spicules. The rays, which are arranged in layers in the longitudinal direction of the cords, are for the most part strikingly prolonged, so that the tissue has the appearance of being composed of irregularly intersecting rods. The free hexradiate spicules are slender, smooth when quite young, but subsequently covered with spines. The rays are very pliable. A beautiful rosette form occasionally occurs, in which each of the six rays is provided with eight intersecting umbels."

Oscar Schmidt's figure,[1] and still more his description, have convinced me that these skeletons dredged by the Challenger in the neighbourhood of the Bermuda Islands (Station 56), from a depth of 1075 fathoms, and on coral mud, belong to *Rhabdodictyum delicatum*, O. Schmidt. They exhibit slender, almost tubular cups, with a length of 6 cm., and much broken at the upper ends (Pl. XX. fig. 1). The basal portion, which is from 6 to 10 mm. in breadth, is attached by means of a terminal expansion to some solid body, and becomes gradually widened upwards to twice this diameter or more. The wall of the tube, which in the larger specimens measures as much as 4 mm. in thickness, is radially perforated by numerous round holes. These are from 2 to 4 mm. in width, and become somewhat broader towards the exterior, at the same time increasing in diameter towards the upper end of the sponge. The arrangement of these parietal apertures is tolerably irregular in the inferior portion, but towards the superior extremity acquires more and more the character of two somewhat steep, intersecting spiral rows. The siliceous framework which forms the supporting wall is usually from 1 to 3 mm. broad between these foramina, and consists of the greatly prolonged hexact-rays firmly united by soldering and synapticula (Pl. XX. figs. 2, 3, 4).

Since the three specimens which are at my command are all incomplete and wholly macerated there is no trace of the soft tissue nor of the looser spicules of the parenchyma, skin, or gastral membrane, so that no conception of the structure of the entire sponge can be obtained sufficient to enable us to determine whether we have here to deal with a

[1] *Loc. cit.*, pl. vii. fig. 3, B.

Euplectellid or not. It is not even certain whether the parietal apertures observed in the skeleton are really open during life, or whether they are covered by the soft parts.

Genus 5. *Rhabdopectella*, O. Schmidt.

Only one species has yet been referred to this genus.

Rhabdopectella tintinnus, O. Schmidt (Pl. XII. figs. 8–12).

Among the Hexactinellida from the Bay of Mexico which have been studied by Oscar Schmidt, a form occurs represented by several fragments and by one whole young specimen, in which the cup-shape manifest in the young form at least, the method in which the spicules are united by fusion and synapticula in the basal part, but more loosely in the upper portion, and further the form of the loose spicules present in the soft parts, justify its reference to the Euplectellidæ, though we do not know either the form or structure of the entire adult sponge. The inferior portion of the mature *Rhabdopectella tintinnus*, as figured by O. Schmidt,[1] presents so firm and stalk-like a mass that in spite of the muddy character of the ground in question, I am far from accepting the opinion of Oscar Schmidt, that a root-tuft must have been present, for the expanded basal plate of the young specimen by no means excludes the supposition that the sponge was fixed to some hard body.

The wide-meshed lattice-like framework of the cup-shaped body, composed as it is of greatly prolonged hexacts and numerous diacts, may well be compared with that of *Regadrella* and other firmly sessile Euplectellidæ. Of the looser spicules Oscar Schmidt has carefully described and figured several noteworthy forms. Among these the floricomes, which agree throughout with *Euplectella* floricomes, deserve special attention; further, there are discohexasters of different kinds—first, those with small transversely disposed stellate plates on the thin extremities of the long secondary rays, of which two or three are attached to every principal ray; secondly, those with hemispherical, marginally toothed terminal umbels borne by the thin, but externally conically thickened terminal rays, of which four occur on each principal, and in which the S-shaped curvature (Pl. XII. fig. 8) produces a mutual entanglement; thirdly, a form resembling the latter but with long, parallel, marginal prickles which run back from the hemispherical terminal disc, close to the axis of the terminal ray; and finally, a very small, on the whole spherical form in which each of the long, thick, principal rays bears five strong terminals. These five terminals are arranged in a regular manner, so that a somewhat shorter straight ray forms the direct extension of the principal, while the four other longer and slightly bent rays are disposed in a cross, and run obliquely outwards. Every terminal ray is provided with a hemispherical

[1] *Loc. cit.*, pl. viii. fig. 9.

terminal umbel, from the lateral margin of which about sixteen pointed teeth project. It is remarkable that these hemispherical or globular terminal umbels are not of equal size, the central having but about half the diameter of the four surrounding it (Pl. XII. fig. 11).

In a fragment of this species which Professor Oscar Schmidt had kindly placed at my disposal, I found a few other rosette forms, namely, first, oxyhexasters with two diverging thin terminal rays on a very short principal (Pl. XII. fig. 9), just like those so frequent in different species of *Euplectella*, and secondly, small discohexacts in which upon the outer extremities of every simple cylindrical principal ray, a hemispherical hollow terminal disc with marginal prongs was so adjusted that the cavity seemed to be directed not inwards but outwards.

The stars which Oscar Schmidt observed in *Rhabdopectella tintinnus*, and which he compared to the *Tethya*-stars, I have likewise seen, and have figured them in Pl. XII. fig. 12. I regard them as oxyhexasters in which the strong terminal rays have at their base grown together laterally on the very short principal rays.

Finally the rough bow-shaped spicules (Pl. XII. fig. 10) deserve to be mentioned. The great resemblance between these forms and those of *Euplectella jovis* has already been noted by Oscar Schmidt.

Genus 6. *Hertwigia*, O. Schmidt.

This genus includes only the single species mentioned below.

Hertwigia falcifera, O. Schmidt.

From a knotted and branched basis, according to Oscar Schmidt's representation, there arises an irregular labyrinth of tubes with thin leaf-like walls, supported by a lattice-like framework of obliquely crossed rods and fibres. Owing to the defective preservation of the upper much damaged portion it was not possible to frame any satisfactory conception of the whole form. Among the looser siliceous spicules, Oscar Schmidt mentions—(1) hexradiate spicules and derivative five- and three-rayed forms, which are for the most part rough towards the point, while others exhibit a fir-tree-like ray with at most very short prickles; (2) rosettes with four intersecting umbel teeth; (3) rosettes with larger teeth on the backwardly bent margin of the terminal umbel; (4) the "specific Euplectella rosettes," that is to say, floricomes; and (5) two kinds of sickle-rosettes, one of which carries on the hemispherical terminal disc of each principal ray several whorls of sickle-like terminal rays, while in the other four large sickle-like teeth are inserted on every principal ray. Rods with numerous oblique lateral prickles at one end are sc ttered here and there. Oscar Schmidt also mentions delicate

siliceous webs whose threads are frequently provided with small terminal hooks or umbels. I would venture to suggest that we have here to deal with the retiform siliceous skeleton of certain Radiolarians in which terminal hooks or pronged terminal discs frequently occur quite similar to the hexasters of Hexactinellida.

This form was found in the neighbourhood of Dominica, on muddy ground, and at a depth of 611 fathoms.

In spite of the characteristic floricome described by Oscar Schmidt, it must still remain doubtful whether this form really belongs to the Euplectellidæ.

Genus 7. *Hyalostylus*, n. gen.

This genus contains only one species, *Hyalostylus dives.*

Hyalostylus dives, n. sp. (Pl. LXX).

This Hexactinellid (Pl. LXX. fig. 1) was dredged in the Mid South Pacific Ocean, lat. 39° 41′ S., long. 131° 23′ W. (Station 289), from a red clay ground at a depth of 2550 fathoms. The soft loose body measures 5·5 cm. in length, while from the lower end there extends a much damaged awl-shaped stalk, 11 cm. long, and 2 to 1 mm. thick. The whole sponge has been apparently so much compressed and distorted in the dredge, that from its present state it is difficult to decide certainly as to the original form of the living organism, though a reconstruction is, to a certain extent, still possible. In general form the body of the sponge resembles a laterally much-compressed cone, of which one of the narrow sides is uniformly rounded and the other much folded. The broader upper end is not transversely, but obliquely truncated, as the rounded, somewhat S-curved narrow side is rather longer than the other, which exhibits a simple convex contour. The upper surface is contracted in funnel-like fashion, and exhibits an irregularly folded infundibular opening. The lower end of the body is not drawn to a point, but is slightly rounded. The stalk springs from the base of the rounded, unfolded narrow side, and becomes gradually slender throughout its length.

As the sponge was given to me for investigation in an undoubtedly much altered form and condition, several questions as to its anatomical structure, and these of essential importance in determining its systematic position, have unfortunately to be left unanswered. Thus it must remain doubtful whether the cup-form of the body represents the original shape, whether the smooth external surface is really dermal, whether the folded portion of one side is merely a part of the external surface, whether the styliform stalk represents the intact form or only a fraction of the original, and so on.

Microscopic examination soon revealed that the tissue was not sufficiently well preserved to admit of the recognition of the arrangement and structure of the chambers,

&c. My description is therefore necessarily restricted to the siliceous spicules, which in delicacy and variety of form are not surpassed by those of any other sponge.

The spicules of the parenchyma are long, filiform, slightly curved, smooth diacts ; the ends are always knobbed and beset with fine spines. The middle point is generally marked by a swollen ring, or by *four* cruciate, or less frequently, *two* opposite bosses (Pl. LXX. figs. 6, 7). Between these long diacts which are isolated and disposed in strands, separate, peculiarly curved oxydiacts occur, and in some situations (*e.g.*, just below the skin) they are even more abundant. They measure about 0·3 mm. in length, and are covered not all round, but on one side, with minute tubercles and warts. Except on this side they are smooth. The curvature of these drawn-out spindles may be generally described as like that of a corkscrew, but both the pointed ends are slightly bent outwards (Pl. LXX. figs. 5, 8). I was not able to detect the axial canal, probably on account of the roughness of part of the surface. Besides the above, the parenchyma contains four different kinds of rosettes. One extremely rare form exhibits at the end of the comparatively short, simple, principal ray, six somewhat markedly diverging, long, straight terminals, arranged in a corona. The basal half of these terminal rays is very thin and delicate, while the outer, terminal half consists of a thicker, cylindrical, terminally rounded portion, like a *Typha*-spike (Pl. LXX. fig. 2). Another somewhat common rosette bears on the short, simple, principal ray a bundle of long S-shaped terminals, with toothed terminal plates which project outwards (Pl. LXX. fig. 3). The filamentous terminal rays, which are slightly thickened at their outer ends, are arranged like petals, but of unequal length—the median being longer than the external.

A third form of rosette is characterised by the inverted bell-shaped umbels formed by the long terminal rays, six of which diverge from the end of each of the short simple principals. These terminal umbels exhibit on the margin of a small, flatly convex, transverse disc, at the end of the terminal ray, about eight fine umbel rays, which extend parallel to one another towards the centre of the rosette, and form along with the terminal umbel an inverted bell-shaped structure (Pl. LXX. fig. 11). The fourth and most frequent form of rosette bears at the end of each of the short, simple, principal rays a bundle of long, thin, radiately disposed terminals, which gradually increase in diameter away from the base, and terminate in small, slightly convex, transverse discs with toothed margins (Pl. LXX. fig. 12). The number of terminal rays on this, often apparently spherical, discohexaster varies greatly. Each principal ray may bear from twenty to forty distinct terminals.

The dermal skeleton consists of smooth hexacts, mostly of median size. Their strong, freely projecting distal ray is club-shaped, *i.e.*, gradually increases terminally into a swollen knob, and occasionally exhibits several tubercles on its outer end (Pl. LXX. figs. 4, 6). The four tangential rays, which are always disposed at right angles, are also thickened terminally, and the conically pointed external end is roughened. The proximal ray is

usually without any, or with only a very slight terminal swelling, and indeed, as a rule, ends in a usually conical, roughened point. The length of the distal and proximal radial rays varies greatly. The tangentials measure, on an average, 0·2 to 0·3 mm. in length, and the distals are not unfrequently of the same size, but the latter may in some situations, *e.g.*, near the lower end of the body, attain more than double the length of the former. The proximal ray exhibits a similar variability, measuring sometimes only 0·1 mm. in length, and in other cases 0·4 to 0·5 or more, while in thickness it always falls considerably below that of the distal.

Here and there, on the external surface, I found simple cruciform tetracts, with smooth knobbed rays, pointed at the extremity (Pl. LXX. fig. 10). The fact that, for the most part, only a few dermalia were to be found on the external surface, is probably to be traced to the injuries which the sponge seems to have suffered by attrition. I found these dermal hexacts most abundantly and in best preservation at the pointed basal extremity of the body, just above the origin of the stalk. They were also abundant, though somewhat displaced, in the deep folds of the already mentioned plicated side of the body, which, if flattened out, would form part of the external surface.

The stalk is chiefly composed of very long needles of various thickness, closely arranged, parallel to the longitudinal axis, and, especially in the inferior portion, frequently bound together by transverse synapticula (Pl. LXX. fig. 9). On the external surface, between the longitudinally disposed diacts, I found forms the same as those above described as parenchymalia, as well as similar hexacts with club-shaped distal rays, and simple cruciform tetracts, somewhat bent towards the surface.

I am not in a position to report so definitely as to the gastral skeletal elements, since I was not able to study them in their natural disposition. In the interior of the body, in the numerous septa, hexacts and pentacts occur in abundance, with somewhat long, smooth rays, which end in slightly club-shaped thickenings; and it seems to me probable that these function as gastralia, though I was unfortunately unable definitely to determine their disposition.

It is clear that this curious form, obtained from the depths of the South Pacific, at a great distance from land, must occupy a peculiar position in the system of the Sponges. On the one hand, the character of the hexact dermalia with their diverging distal rays would suggest an alliance with the family of the Euplectellidæ, in which, further, such remarkable twisted oxydiacts alone occur (in *Rhabdoplectella tintinnus*, Pl. XII. fig. 11); while, on the other hand, all the microscopic characters of the body, and the sharply defined, long, narrow stalk indicate a closer resemblance to such forms as *Crateromorpha*, *Aulochone*, and especially *Caulocalyx* (Pl. LXIX.), to which we shall have again to refer in detail.

Family II. Asconematidæ.

Lyssacina of sack-, tube-, beaker-, or mushroom-like form, fixed either directly or by means of a round stalk. The body-wall, which is not perforated, forms a thin soft plate or a compact mass, which represents either the thick wall of a beaker, or the arched plate of a mushroom-like body. In the latter case the gastral surface has become the convex outer side.

Both dermal and gastral surfaces are densely and uniformly beset with hexact and pentact pinuli, in which the freely projecting fir-tree-like ray is prominently developed, while the parenchymal ray is usually small or entirely atrophied. The four transverse rays, which are cruciately disposed, lie embedded in the bounding skin, and the whole spicules are accordingly designated autodermalia and autogastralia. Below these pentact hypodermalia and hypogastralia occur.

The rosettes which lie scattered between the diact or hexact principalia are for the most part discohexasters.

Subfamily 1. Asconematinæ.

Sessile sack-, cup-, or tube-like Asconematidæ, with a thin, flabby, pliable wall.

Genus 1. *Asconema*, Saville Kent.

1870. S. Kent, Monthly Micr. Journ., Nov., p. 241 (*Asconema setubalense*).
1871. Gwyn Jeffreys, Proc. Roy. Inst., N. 54, p. 258.
1872. Gray, Ann. and Mag. Nat. Hist., vol. ix. p. 442.
1873. Thomson, Depths of the Sea, p. 429.
1874. Carter, Ann. and Mag. Nat. Hist., vol. xii. p. 349.
1874. Gray, Ann. and Mag. Nat. Hist., vol. xiii. p. 284.
1875. Marshall, Zeitschr. f. wiss. Zool., Bd. xxv., Suppl., p. 142.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii. p. 113.
1880. Norman, Ann. and Mag. Nat. Hist., vol. vi. p. 430.
1880. O. Schmidt, Spongien des Meerbusens von Mexico, ii. p. 65.
1881. Milne-Edwards, Comptes rendus, xciii. p. 876.
1885. Filhol, La vie au fond des mers, p. 288.

History.—Among the marine Sponges preserved in the Lisbon Museum of Natural History, Saville Kent detected in 1870,[1] on the occasion of the "Norna" expedition, some large, but only partially preserved cup- or sack-shaped specimens of "felt-like consistence, composed of an interlacement of long filiform siliceous fibres or spicules, and, interspersed among these, hexradiate spicula of various sizes and minute multiradiate ones with capitate extremities." For these specimens he erected a special genus, *Asconema*, and characterised the single representative species, *Asconema setubalense*, in the following

[1] *Monthly Micr. Journ.*, p. 245, 1870.

words:—"Sponge body, vase- or sack-like, of large dimensions, expanding superiorly, often upwards of two feet in height; composed of interlacing fasciculi of long filiform fibres or spicula. Individual filiform spicula smooth, finely canaliculate, varying in diameter from $\frac{1}{6000}$th to $\frac{1}{500}$th of an inch, occasionally possessing a central or excentral inflation, as at plate lxiv. fig. 4. Hexradiate spicula of two types, the one large, with smooth alternate radii, the other of smaller but more varying size, with obtuse extremities and entirely erectly spinous surfaces. Scattered through this sponge there also occasionally occur simple alternate spicula, clavate and erectly spined at either extremity (see plate lxiv. fig. 5). Average diameter of the minute multiradiate spicule $\frac{1}{300}$th of an inch." From the fact that the base was absent in all the specimens, Saville Kent was led to conclude that the lower portion of the cavity, where the sponge is fixed by its base to the sea-bottom, was filled with mud, and that it must thus have been constantly torn off during the process of fishing up the sponge.

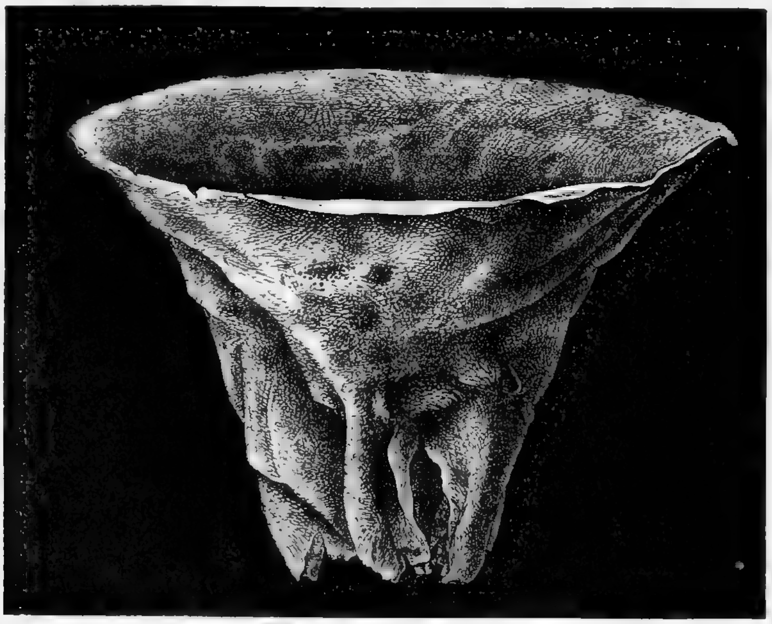

FIG. 3.—*Asconema setubalense*, Sav. Kent, one-eighth the natural size, from Wyville Thomson's Depths of the Sea, p. 429.

A giant specimen of this species, with a diameter of 3 feet, was dredged by Gwyn Jeffreys[1] off Cape St. Vincent on the coast of Portugal, on rocky ground and from a depth of 374 fathoms.

In his Classification of Sponges,[2] Gray forms Kent's genus *Asconema* into a special family, the Asconematidæ, with characters essentially similar to those noted by Kent in regard to the genus and the single known species. A large and comparatively well-

[1] *Proc. Roy. Inst.*, No. 54, p. 258, 1871. [2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ix. p. 458, 1872.

preserved specimen of *Asconema setubalense*, which was dredged "in 374 fathoms on rocky ground off Cape St. Vincent, during Mr. Gwyn Jeffrey's cruise in 1870," is described by Wyville Thomson,[1] and depicted in an excellent woodcut. He calls it "a complete vase of very elegant form, nearly ninety centimetres in diameter at the top, and about sixty in height. The sponge came up folded together, and had much the appearance of a piece of coarse greyish-coloured blanket. Its minute structure is however very beautiful. It consists, like Holtenia, of two netted layers, an outer and an inner, formed by the symmetrical interlacing of the four cross branches of five-rayed spicules; and as in Holtenia and Rossella, the sarcode is full of extremely minute five and six-rayed spicules, which, however, have a thoroughly distinct character of their own, with here and there a very beautiful rosette-like spicule, another singular modification of the sexradiate type characteristic of the group. Between the two netted surfaces the sponge surface is formed of loose curving meshes of loosely aggregated bundles of long single fibres, sparsely mixed with spicules of other forms. This sponge seems to live fixed to a stone. There are no anchoring spicules, and the bottom of the vase, which in our two specimens is a good deal contracted and has a square shape something like an old Irish "mether," has apparently been torn from some attachment."

Carter, in his paper on the Hexactinellida,[2] has noted certain agreements between *Asconema* and *Crateromorpha*. He says—"In Asconema the small sexradiate spicules with short-spined arms (of which the vertical one on one side is often deficient) and formed together in groups, recall to mind the same kind of spicules (which form a rectangularly reticular network) on the surface of *Crateromorpha meyeri* and *Rossella velata*. Indeed, so far as this goes, Asconema might be considered a sessile vase-like representative on the coast of Portugal of the cup-like head of Crateromorpha found about the Philippines only."

Some siliceous elements figured by Kent as skeletal spicules of *Asconema setubalense*,[3] which do not exhibit the hexradiate type, were declared by Carter not to belong to this Hexactinellid but to have been most probably intruded from a *Pachastrella abyssi*.

With regard to the affinities of this form among the Hexactinellida, Marshall[4] conjectures that *Asconema*, which he refers as an aberrant form to his Pleionacidæ, is closely related to *Lanuginella*, Schmidt, that the latter, in fact, is probably a young *Asconema*.

Norman reported[5] that, during the voyage of the "Travailleur," "a little bunch of the strong coarse spicula of the great *Asconema setubalense* was dredged in the Bay of Biscay, in about 600 fathoms."

As a second species belonging to the genus *Asconema*, Kent, Oscar Schmidt described[6] his *Asconema kentii*. This was found in from 300 to 1500 fathoms, in the

[1] The Depths of the Sea, 1873.
[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. pp. 369, 370, 1873.
[3] *Loc. cit.*, figs. 10, 11.
[4] *Zeitschr. f. wiss. Zool.*, Bd. xxvii. p. 121.
[5] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. vi. p. 436.
[6] Spongien des Meerbusens von Mexico, p. 65, 1880.

neighbourhood of Grenada, Martinique, Guadeloupe, and Bequia. He speaks of this new species as follows :—"It occurs in two varieties ; the one resembles a shallow or but moderately deep cup, which is provided inferiorly with a rounded or short, often somewhat irregularly twisted, pointed stalk ; the other is sack-like, with an irregular margin, with irregular pocket-like divisions and excavations, which are separated by somewhat thin lappet-like partitions, just like a beggar's sack. The latter forms are a foot in length and seem to be sunk in the mud up to the upper margin." In a netted covering-layer, which is particularly well developed in the beaker-like variety, O. Schmidt found fir-tree-like spicules. "On the margin of the beaker-like variety the covering-layer usually projects as a plaited fringe, and extends from the outer towards the inner surface. Above this there projects a dense row of imperfectly developed hexradiate spicules, and needles with an axial cross. The whole body is unusually rich in double 'quirls,'[1] which vary greatly in dimensions and in individual form."

Oscar Schmidt notes especially that although *Asconema kentii* agrees completely in the form, consistence, and especially in the felt-like condition of its walls with *Asconema setubalense,* Kent, the agreement by no means extends to the spicules.

The dried specimen of this species was kindly lent to me by Oscar Schmidt, and is figured in Pl. XXX. fig. 9. That it does not belong to the genus *Asconema,* but to *Hyalonema,* will be pointed out in the detailed description of the characteristics of the species *Hyalonema kentii,* which will be given below.

In a short report on the voyages of the French ships "Travailleur" and "Talisman," Filhol[2] gives a woodcut and the following notices of *Asconema setubalense :*— 'L'Asconema setubalense n'avait été trouvé jusqu'au voyage du Talisman que sur les côtes du Portugal. Lors de la campagne de ce dernier bateau, nous l'avons recueilli sur les côtes du Maroc, au voisinage du cap Bojador, par 410 mètres. Les deux exemplaires que nous en avons obtenus vivaient fixés par leur base sur des roches ou sur des coraux (Lophohelia) dont le chalut contenait de nombreux débris." And on p. 289 :—"Les Asconema ont été trouvées avec les Aphrocallistes."

The genus contains only one species.

Asconema setubalense, Saville Kent (Pl. XXI).

A thin-walled cup in which the wide superior opening is surrounded by a simple, smooth, thin margin, while the narrowed inferior extremity seems to be firmly fixed. Among the sponges of the expedition of H.M.S. "Triton," which were entrusted to me for review, I observed the fragment figured in Pl. XXI. fig. 1, and some small specimens of a Hexactinellid, which, after comparison with Kent's original in the

[1] Quirl = a short round stick provided with a toothed disc on one extremity.
[2] La vie au fond des mers, p. 285, fig. xcii., 1885.

British Museum, I regard as identical with the sponge named *Asconema setubalense* by Saville Kent. The specimens in question were trawled at Station 4 of the "Triton" expedition, from a depth of 327 to 430 fathoms, and were preserved in absolute alcohol. By means of this fitly selected medium the soft parts were especially well preserved.

The principalia of the parenchyma are strong, smooth diacts, 1 cm. or more in length, pointed at both ends, and usually exhibiting in the middle a small knot-like swelling. They lie parallel to the bounding surface at different levels, and are distributed with comparative irregularity. Every principal ray is surrounded by a layer of thin diact comitalia which extend over its surface in gently undulating curvature.

The parenchyma also contains a rich abundance of thin rod-like diacts of small size, separately or in bundles, and disposed in different directions. Of these many exhibit a central swelling (Pl. XXI. figs. 7–10), and either terminate in sharp points (Pl. XXI. figs. 9, 10), or are provided with rough knob-like swellings on one or at both extremities (Pl. XXI. figs. 7, 8).

Between all these rod-like spicules four different kinds of rosettes occur in irregular distribution:—namely (1) simple oxyhexasters with long terminal rays, two or three in number, and running out in a diverging manner from the principal (Pl. XXI. fig. 12); (2) smaller oxyhexasters in which each of the broad, moderately short principal rays bears a bundle of three to twelve fine terminals (Pl. XXI. fig. 6); (3) quite small discohexasters in which each of the broad principals bears a strongly-developed, diverging brush-like bundle of numerous fine terminal rays with terminal knobs (Pl. XXI. fig. 3); and (4) discohexasters twice the size of the above, with short principal rays, each of which exhibits six long, thickly barbed, cylindrical terminals. These are disposed either in a tuft or round a funnel-shaped space, and terminate in an arched terminal disc with several prongs (Pl. XXI. fig. 11).

The *dermal skeleton* is supported by tolerably large, simple, smooth hypodermal pentacts. In the dermal membrane itself lie the four cruciate transverse rays of small pentacts, from each of which a distal radial, as long as the transverse, projects outwards, while the proximal radial ray is reduced to a small rounded peg. The five developed rays of these autodermalia are thickly beset with small outwardly directed prongs, while the proximal stump appears to be smooth (Pl. XXI. fig. 4).

The *gastral skeleton* is very similar. Here also large, smooth, pentact hypodermalia (not introduced into the diagrammatic figure 2) are present. The gastral membrane contains the cruciate transverse rays of pentacts, in which the proximal ray projects inwards into the gastral cavity, while the radial is rudimentary. The five developed rays, like those of the autodermalia, are beset with prongs. Between the pentact autogastralia, hexacts also occur here and there. In these the distal ray enters into the parenchyma, and has the same length and development as the proximal ray opposite to it (Pl. XXI. figs. 2, 5).

Genus 2. *Aulascus*, n. gen.

This genus only contains one species.

Aulascus johnstoni, n. sp. (Pl. XXII. figs. 1–3).

The loose and readily pliable tube-like fragments which are figured in Pl. XXII. fig. 1, have a wall from 2 to 4 mm. in thickness, and were dredged in the southern part of the Indian Ocean, about halfway between the Cape of Good Hope and the Kerguelen Islands, at Station 145A (lat. 46° 41′ S., long. 38° 10′ E.), from a depth of 310 fathoms, and a bottom of volcanic sand. While the inferior portion of both tubes is entirely destroyed, a simple, sharp, smooth margin occurs on the somewhat widened upper portion of one of them. Both the outer and the inner surfaces are covered by a continuous thin skin, through which irregularly scattered cavities of variable widths (up to 2 mm. in diameter) may be seen.

In the parenchyma the principalia consist of moderately large hexacts with rough ends which run out gradually to a point, and of numerous straight or slightly bent diacts, which occur partly in bundles and partly isolated, and are provided with a central thickening and with rough ends running out gradually into points. While the hexacts are usually disposed at right angles to the bounding surfaces, the diacts are for the most part parallel to these or arranged obliquely in different directions.

Between the principalia numerous irregularly scattered rosettes appear. Among these discohexasters predominate, and each of their principal rays is divided into two or three diverging straight terminals. The latter decrease in size towards the exterior, are densely beset with numerous short hooks, and terminate in a small, slightly arched, transverse disc which runs out into four or more prongs. In some cases the outer extremities of the terminal rays are so delicate, and the terminal transverse disc so small, that the latter can only be seen with high magnifying powers, and the whole rosette resembles an oxyhexaster.

The plumicomes (0·05 mm. in diameter), indicated in Pl. XXII. fig. 2, and figured in fig. 6 from another sponge, occur here and there. The extremity of each of the moderately long, round, principal rays bears a tolerably thick, round, transverse disc, on the convex outer side of which the fine terminal rays, which are bent in an S-shaped manner, arise in concentric circles and together form a cup.

The *dermal skeleton* is supported by moderately large pentact hypodermalia with rough ends, which gradually run out to fine points. The abortive distal ray is sometimes indicated by a round tubercle. The dermal membrane itself contains the four cruciate transverse rays of the hexact autodermal pinuli, in which the freely projecting distal ray is beset with scaly prongs, like a fir cone, in its larger outer principal portion, while the base remains naked (Pl. XXII. fig. 3). The pole-like pointed proximal is

provided, like the similarly formed four transverse rays, with fine outwardly directed prongs, and is smooth only on its inmost portion.

The *gastral skeleton* is quite similar. Here too pentacts of median size occur as hypogastralia. These have rough pointed extremities and a knob-like rudiment of the sixth ray, while the four cruciate transverse rays of the hexact pinuli, in which the freely projecting proximal ray is covered with scaly prongs like a fir cone, lie in the gastral membrane itself. The distal which is as long as the transverse rays, is like the latter beset, except in its inmost portion, with small outwardly directed prominences. They differ from the autodermalia only in this, that the freely projecting fir-cone-like ray is here somewhat more slender, although in both it runs out to a point.

Subfamily 2. Sympagellinæ.

Ovoid, thick-walled, usually (perhaps always) stalked goblets, with smooth, thin upper margin. Between the principal hexacts small discohexasters and long diacts.

Genus 1. *Sympagella*, O. Schmidt.

1870. O. Schmidt, Grundzüge einer Spongienfauna des atlant. Gebietes, p. 15.
1872. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. ix. p. 457.
1873. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xi. p. 283.
1873. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xii. p. 360.
1875. Marshall, Zeitschr. f. wiss. Zool., Suppl., p. 142, 1875.
1876. Marshall, Zeirschr. f. wiss. Zool., Bd. xxvii. p. 127.
1881. Milne-Edwards, Comptes rendus, xciii. p. 931.

History.—Under the name *Sympagella nux*, O. Schmidt described and figured a Hexactinellid obtained off Florida from a depth of 98 to 123 fathoms; it presented the form either of a single individual with an ellipsoidal body, about 1 cm. high, with a terminal osculum and a simple stalk, or of a branched stem with several terminal individuals of similar nature.

In the membrane covering the external surface of the body and lining the gastral cavity O. Schmidt found pentact pinuli with a rudimentary sixth ray, and in the latter situation also "nodular hexacts." In the parenchyma were numerous small hexacts with three barbs situated on the end of each ray. In the stalk were long tubercula united by transverse hour-glass-shaped connectives. It was probably on account of these ladder-like structures that Gray[1] in 1872 placed *Sympagella* along with *Farrea* in his family Farreadæ.

In 1873 Carter[2] discovered in *Sympagella nux* "rosettes with rays multitudinous, of unequal length, without heads, flexed outwards and arranged *en fleur-de-lis;* pappiform."

[1] Notes on the Classification of the Sponges, *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ix. p. 457.
[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 361.

Sympagella nux also appears in Milne-Edwards' list, published in 1881, of the specimens collected by the "Travailleur" on the coasts of Spain and Portugal.

This genus contains only one species.

Sympagella nux, O. Schmidt (Pl. XXII. figs. 4–9).

The much injured specimen of *Sympagella nux*, O. Schmidt, which is figured in Pl. XXII. fig. 4, was obtained on coralline mud in the neighbourhood of the island of St. Iago, one of the Cape Verde Islands, from a depth varying from 100 to 128 fathoms. The body is branched like the horns of a stag, and from its round principal stem, which is 1·5 mm. in thickness, two somewhat bent more delicate side branches arise on the same side. The upper extremity of the principal stem, which is broken off beneath, forms an oval body, which is 1 cm. long and 6 mm. broad. The superior transversely truncated extremity of the latter bears the orifice (2 mm. in width) of a simple gastral cavity. The latter is slightly narrowed towards the base of the body, and ends blindly without being continued into the stalk. While the outer surface of the body-wall (which is 2 mm. in thickness) is surrounded by a continuous skin, through which small cavities can be seen only here and there, larger efferent passages appear on the inner surface, and open directly into the gastral cavity. It is indeed possible that the gastral membrane may have been torn or otherwise injured where it extended over the inner openings of the efferent canal system. The upper lateral branch exhibits the lower fragment of a torn-off body.

The principalia of the parenchymal skeleton consist, as in *Aulascus*, of simple, regular, moderately strong hexacts, with somewhat rough pointed extremities, and of numerous diacts, varying in strength, length, and direction. In these the centre swelling sometimes exhibits four cruciately disposed knobs, sometimes an annular elevation, or sometimes only the merest trace. The diacts are straight or slightly bent, and run out to similar points at both ends. A slight roughness frequently occurs in the neighbourhood of the terminal points.

With regard to rosettes, discohexasters are particularly abundant in the parenchyma, and are provided with short principal rays, and long diverging terminals uniformly thin, or slightly thickened towards the outer end. The latter are smooth or very slightly roughened, and terminate in a watch-glass-shaped arched disc, provided with six to eight marginal prongs. Each principal ray bears three, or less frequently four, terminal rays. These are strong at the base, diverge in an arch-like curve, and then continue in a straight or slightly bent course.

Besides these discohexasters, the plumicomes which are found in *Aulascus johnstoni* also occur, but I have found them only in scattered distribution. Finally, the parenchyma contains here and there peculiar structures, which Oscar Schmidt called "roller stars"

(Walzensterne). Short strong prickles, usually three at each extremity, diverge from both ends, and frequently also from the middle of a somewhat thick, straight, or slightly bent roller-like body. I regard these roller stars as reduced oxyhexasters, in which only one axis, with the two principal rays and the associated terminals, has attained full development, while the other four rays are either entirely atrophied, or are reduced to short transverse prickles (Pl. XXII. fig. 7, *a*, *b*, *c*).

The dermal skeleton consists of simple, moderately strong, pentact hypodermalia and pentact autodermalia in the form of pinuli. In the latter the fir-tree-like distal ray, which measures 0·1 mm. in length, is naked at the base, broadest in the middle, and runs out to a point superiorly, while the four transverse rays lying in the dermal membrane bear on their larger outer portion small points and irregularities. A small, rounded, smooth peg appears in the place of the atrophied proximal ray (Pl. XXII. fig. 8).

The simple pentact hypogastralia completely resemble the hypodermalia, nor do the inwardly projecting gastralia differ much from the corresponding (inwardly projecting) dermalia. These are very long, outwardly bent, slender hexacts, in which the narrow pointed proximal ray which projects freely into the gastral cavity is beset only with short prongs, which run obliquely outwards and attain a length of 0·5 mm. or more, while the similarly armed pointed distal, which projects into the parenchyma, measures only 0·17 mm. in length, and the similarly formed four cruciate transverse rays, are only about 0·1 mm. long (Pl. XXII. figs. 5, 9).

The stalk exhibits the same general structure as the body, except that the hexact principalia fall into the background as compared with the extraordinarily prolonged diacts, which are all arranged parallel to the long axis, and which, as Oscar Schmidt accurately describes,[1] are firmly united laterally by numerous synapticula. The size of the hypodermalia decreases downwards, and they are, moreover, pronged and rough.

Discohexasters, plumicomes, and "roller stars" may be found in the stalk in almost as great abundance as in the body.

Genus 2. *Polyrhabdus*, n. gen.

The genus contains only the one species, *Polyrhabdus oviformis*.

Polyrhabdus oviformis, n. sp. (Pl. XXIII. figs. 1–8).

In the Antarctic Ocean (lat. 62° 26′ S., long. 95° 44′ E.) there was trawled from a depth of 1975 fathoms, and a bottom of Diatom ooze, the considerably damaged and triturated egg-shaped specimen represented in Pl. XXIII. fig. 1. It measures 2 cm. in length and

[1] *Loc. cit.*, pl. i. figs. 10–12.

12 mm. in its greatest diameter. The narrower upper end bears the circular opening of the simple gastric cavity, which is 6 mm. in diameter, and 10 mm. in depth. The body-wall, which is inferiorly from 3 to 4 mm. in thickness, becomes very gradually attenuated upwards to the narrow smooth border. It is impossible to tell whether this oval body was fixed upon a stalk, since the inferior extremity is greatly triturated.

Most of the somewhat thickly crowded parenchymal spicules are straight diacts of variable length and of moderate thickness. They usually exhibit on either end a slender olive-like thickening, which is beset with small points and prongs. Such irregularities also occur where the thickening is absent, on the simple rounded ends (Pl. XXIII. fig. 7). In the middle the rods exhibit either four cruciately disposed tubercles (Pl. XXIII. fig. 6) or a circular wreath. Less frequently the central swelling is insignificant or entirely absent, and the central portion appears often to be marked only by the intersection of the axial canals. Between the very irregularly disposed diacts, which lie, however, for the most part parallel to the outer surface, there occur moderately large, usually radially disposed hexacts, whose rays run out to points for a greater or less distance, and are frequently beset with pointed tubercles, either all over or at the extremities (Pl. XXIII. fig. 5).

Besides these principal spicules numerous rosettes occur in the form of discohexasters with six, eight, or more similar thin diverging terminals on every principal ray. The watch-glass-like bent terminal disc of every terminal ray runs out into six or more pointed marginal prongs (Pl. XXIII. fig. 3).

The dermal skeleton includes strong pentact hypodermalia; I have not, however, seen either these or the autodermalia *in situ*. The latter are hexact pinuli in which the thicker oval distal ray, which resembles a fir cone, is beset all round with scaly prongs, while the proximal and the four transverse rays are smooth up to the pointed roughened extremities (Pl. XXIII. fig. 4).

The hypogastralia resemble the hypodermalia; the autogastralia differ from the autodermalia in this, that their freely projecting ray is narrower and longer than in the latter (Pl. XXIII. fig. 2).

Genus 3. *Balanites*, n. gen.

Containing only one species, *Balanites pipetta*.

Balanites pipetta, n. sp. (Pl. XXIII. figs. 9–14).

The single specimen, which resembles a clay pipe or cigar holder, and which is figured in Pl. XXIII. fig. 9, was trawled in the Antarctic at Station 157 (lat. 53° 55′ S., long. 108° 35′ E.), from a depth of 1950 fathoms, and a Diatom ooze bottom. The oval body, which measures 5 cm. in length and 1·5 cm. in thickness, is continued by a

gradually narrowed inferior portion into the obliquely inserted, round, hollow stalk, which is 3 mm. in diameter, and has been torn off at a distance of 3 cm. from the body. The upper transversely truncated extremity of the latter exhibits the circular aperture (9 mm. in width) of a simple gastral cavity, which is 2 mm. in depth, and ends beneath in a blind sack-like manner. The tolerably compact body-wall is about 5 mm. in thickness beneath, and becomes gradually attenuated upwards to the narrow smooth border of the opening. I was not able to observe a direct continuation of the gastral cavity into the cavity of the tubular stalk, though such a connection may be present.

Among the principalia of the parenchymal skeleton the strong regular hexacts with simple smooth rays occupy the first place. Diacts of variable length, however, with pointed or rounded extremities, occur scattered or in bundles and disposed in different directions. They are for the most part destitute of any central swelling, but the intersection of the axial canals is frequently recognisable.

Between these large parenchymal spicules numerous small regular hexacts occur, with strong rays which decrease in diameter towards the extremities, which are beset with small thorns and bear at the very tip a small arched terminal disc with six or more bent marginal prongs. Sometimes, too, one or other ray may be found to be divided almost to the middle into two or three diverging branches. These exceptional forms lead to a rosette which occurs here and there, and is figured in Pl. XXIII. fig. 12. Here four to six strong diverging terminals, half the length of the principals, stand on each extremity of the proportionally long, smooth or slightly tuberculated, principal rays. These straight or slightly bent thin terminal rays are provided with lateral thorns, and bear on each of their extremities a transverse disc provided with several marginal prongs. Another rosette which is figured in the same plate (figs. 10, 11) occurs far more abundantly than the form mentioned. This consists of long smooth principal rays which are terminated by a small discoid expansion. The flat outer surface of the disc bears a tuft of short delicate terminal rays provided with pronged terminal discs. The outermost circle of terminals, are bent in an S-like manner.

The essential agreement between the dermal and gastral skeleton is here particularly manifest. The transition from the one to the other occurs quite imperceptibly on the rounded margin of the large oscular opening (Pl. XXIII. fig. 14).

Both hypodermalia and hypogastralia are strong and tolerably large pentacts, in which each of the strong radial principals is beset on its middle portion with isolated spines, while the four transverse rays are smooth throughout.

The autodermalia are hexact pinuli with broad, scaly, pronged, oval, fir-cone-like distal rays, while their moderately long proximals, like the somewhat longer transverse rays, remain quite smooth (Pl. XXIII. fig. 13) up to the conically narrowed, rough or pronged, terminal portion. The autogastralia differ from the autodermalia only in their smaller breadth, and in the more slender, smooth basal portion of the freely projecting scaly ray.

Subfamily 3. Caulophacinæ.

Fungiform, with a long cylindrical tubular stalk.

Genus 1. *Caulophacus*, n. gen.

Fungiform, with a long tube-like stalk. The gastral surface of the body has become convexly arched by eversion. The dermal surface has either remained convex or has become concave by a turning over of the marginal portion.

Caulophacus latus, n. sp. (Pl. XXIV.).

About halfway between the Cape of Good Hope and the Kerguelen Islands (Station 147, lat. 46° 16′ S., long. 48° 27′ E.), from a depth of 1600 fathoms and Diatom ooze ground, a Hexactinellid was trawled, which exhibited in its external form a marked resemblance to a flat mushroom. The body is a circular disc, 15·5 cm. in breadth, with a thickened median portion continued downwards by means of a conical neck into the rounded hollow stalk. The latter is 5 mm. in thickness, and is bent obliquely to the side in its upper portion, which is alone preserved. While a shallow depression occurs in the middle of the upper surface, the gradually narrowed marginal portion, which finally terminates in a narrow smooth border, is bent slightly downwards (Pl. XXIV. fig. 1). On making a section at right angles to the surface (Pl. XXIV. fig. 1), the afferent and efferent canals are clearly recognisable, and they may even be detected through the uninjured dermal and gastral membranes. These canals are disposed at right angles to the bounding surface. The cavity of the tubular stalk, which is 2 mm. in width, is continued upwards into the efferent system of lacunæ in the median part of the disc (Pl. XXIV. fig. 1).

Since the upper usually slightly convex surface of the body, which exhibits only in the middle a shallow depression, corresponds to the gastral surface, it is only natural that all the chambers of the richly folded chamber layer should have their wide excurrent openings turned towards this convex surface, and their blind sack-like extremities on the other hand directed towards the concave dermal region. Here, too, as in all other cases, the water enters through the dermal membrane, and passes through the sieve-like network of the chamber walls in flowing from the outside inwards.

The principal parenchymalia are moderately strong, simple, regular hexacts, with smooth rays, each of which runs out to a sharp point, and smooth diacts varying in breadth and length, and provided on both sides with a rough rounded terminal portion. Between these there is an abundant though scattered occurrence of small prickly hexacts (0·25 mm. in diameter) with arched and marginally pronged transverse terminal discs

(Pl. XXIV. fig. 7) exactly like those which we have already noted in *Balanites*. Simple oxyhexasters also occur with short principal rays, and long, frequently somewhat rough, terminals. The division of one or several principal rays often does not take place, so that, as in Pl. XXIV. fig. 8, some rays become divided into two or three terminal rays, while others which remain undivided are straight and run out to a sharp point.

Rosettes are represented only by the form figured in Pl. XXIV. figs. 4 and 6. Each of the six smooth and moderately long principals passes into a narrow conical tuft of eight or more almost similar, straight, fine terminal rays, each of which is somewhat rough towards the extremity and is provided with a small, convex, marginally pronged, terminal plate. Here and there, abnormally, one or other of the secondary rays does not occur on the extremity of the principal ray but laterally, and is inserted more or less close to the axial node as if it had moved down to this position.

The pentact hypodermalia have a strong radial ray which is wholly or partially beset with spines, while the four transverse rays which are spread out beneath the dermal membrane but rarely exhibit small spines, and usually appear somewhat roughened on their bluntly pointed extremities.

The autodermalia are hexact pinuli in which each of the freely projecting (usually 0·05 mm. long) distal rays resembles a crowded oval fir cone with a short smooth stalk (Pl. XXIV. fig. 10), or is more rarely narrower and longer (Pl. XXIV. fig. 2).

The four slightly conical transverse rays lying in the dermal membrane, and the somewhat shorter proximal ray, are only beset with small prongs on the outer portion.

While the hypogastralia do not differ essentially from the hypodermalia, the autogastralia which project over the whole convex upper side of the body of the sponge differ essentially from the autodermalia, inasmuch as the freely projecting, and at the same time distally directed ray, is very long (1 mm. or more), narrow, drawn out to a fine point, and also beset with relatively short prongs (Pl. XXIV. fig. 5). On the other hand, the ray directed towards the parenchyma is greatly reduced, or has entirely disappeared, so that the majority of autogastralia no longer represent hexacts but pentacts, in which the short, conical, transverse rays are beset with small prongs either on the outer extremities alone or all over.

The difference between the short crowded hexact autodermalia and the long pointed pentact autogastralia is very clearly indicated on the outer margin of the disc where both border on one another, yet it may also be readily recognised on the other side by the shorter projecting distal ray and the short proximal ray of the outermost autogastralia. Both are really but different members of the same series.

It is noteworthy that in those autodermalia with a greatly prolonged distal ray, which occur here and there between the short and crowded forms, the inner proximal ray is usually absent (Pl. XXIV. fig. 3).

In the parenchyma of the stalk the principal hexacts are in the minority, and the

long diacts with rough rounded extremities are accordingly all the more abundant. These are here, moreover, not so uniformly disposed in a longitudinal direction as in thinner stalks, but occur with some irregularity, though for the most part longitudinally. These principalia are extensively united into a firm framework by means of synapticula. It is to be regretted that the dermal skeleton of the stalk has been rubbed off, and also that the inner lining of the cavity of the stalk is no longer intact.

Caulophacus elegans, n. sp. (Pl. XXV.; Pl. XXVI. figs. 1–3).

A second species of *Caulophacus* was trawled to the east of Japan (Station 241, lat. 35° 41′ N., long. 157° 42′ E.) from 2300 fathoms, on red clay ground. Three specimens were collected, two of them small forms with short imperfect stalks. One of these, as figured on Pl. XXVI. fig. 1, shows a marked resemblance to *Caulophacus latus*. The straight, round, hollow stalk, 1·5 mm. in diameter, is continued by a trumpet-like expansion into the slightly curved superior extremity with a convexo-concave circular disc, with somewhat overhanging margins. In the specimen figured the diameter of the disc measures almost 2 cm., and the greatest thickness 5 mm. Another much injured specimen is somewhat smaller. A tolerably distinct form is figured in Pl. XXV. fig. 1, from a somewhat larger third specimen. The hollow stalk is somewhat bent at the end, and though on the whole straight, is slightly curved here and there in an undulating manner. It measures 3 mm. in diameter, and bears terminally a biconvex lens-shaped disc, 4 cm. in breadth and 1·5 cm. in thickness, with a somewhat downwardly bent margin. In spite of some superficial irregularities on the upper side and several shallow folds below, both surfaces appear on the whole to be uniformly arched, though the upper is the more convex. The stalk, though broken off below, attains a length of 9 cm. I am inclined to believe that the piece of stalk which was brought up along with the former, and which exhibits a similar structure and a length of 15 cm. (Pl. XXV. fig. 2), really belonged to the same specimen, and formed the inferior extremity of the stalk, which would accordingly measure 24 cm. in length.

As in *Caulophacus latus*, the principalia consist of strong, regular, smooth hexacts, and long diacts with rounded, more or less rough, extremities. These have an isolated or a bundle-like distribution. Each of the rays of the hexacts exhibits a bulging swelling in the middle, and a rounded terminal point. The diacts usually exhibit a central axial canal intersection, but as a rule there are no knob-like protuberances or ring-like swellings to represent the remnants of abortive rays. Between the principalia the same small regular pronged hexacts, with marginally pronged, arched, terminal plates, occur in great numbers, resembling those which we have already become acquainted with in the other species, and in *Balanites pipetta* (Pl. XXIV. fig. 7). Simple division of a ray, as shown in Pl. XXV. fig. 7, may occasionally be observed. On the other hand,

regularly developed discohexasters are of by no means rare occurrence. These are provided with numerous (eight or more) prong-bearing, long, terminal rays, which are placed upon the terminal expansion of the short smooth principal ray, and do not differ essentially in other respects from the rays of the discohexacts (Pl. XXV. fig. 6). It is remarkable that these many-rayed discohexasters lie almost exclusively under the surface of the disc, and that scattered between them similar rosettes occur, with a few (often only four or three, or even two) pronged terminal rays on every principal. One can detect a tolerably continuous series of transitions between the simple pronged hexacts and those many-rayed discohexasters.

Sometimes I also observed rosettes with numerous long, smooth, pointed, terminal rays, *i.e.*, oxyhexasters. The terminal rays are inserted on a terminal expansion of the short principal rays like those of the discohexasters.

The slight differences in the numerical proportions of the discohexacts and discohexasters, in the thickness of the terminal rays and in the direction of the same, which are discoverable between the smaller fungiform specimens and the larger forms with lens-shaped bodies, I regard as insufficient for the differentiation of particular species.

The dermal skeleton resembles very much that of *Caulophacus latus*. Here, too, the proximal ray of the pentact hypodermalia is usually beset with prongs (Pl. XXV. fig. 8), and the autodermalia are hexact pinuli with broad, short, fir-cone-like outer rays, while their slightly conical transverse rays and the similarly formed proximal ray only exhibit a slight irregularity of surface on the terminal portion (Pl. XXV. fig. 5).

The gastral skeleton lying on the convex upper side differs from the corresponding skeleton of *Caulophacus latus* only in the fact that the autogastralia are not pentact but hexact pinuli, in which both the developed proximal, and the four transverse rays, are smooth and only slightly rough on the extremity, while the freely projecting, scaly, pronged distal ray is not so narrow and pointed as in the latter, but becomes outwardly broader and more swollen, so as to terminate in a knob-like rounded extremity (Pl. XXV. fig. 4).

The parenchyma of the tube-like stalk contains, just as in *Caulophacus latus*, somewhat rough, rod-like diacts, which are rounded at both extremities. They are greatly increased at the expense of the hexacts, which have disappeared, and are almost all approximately parallel to the long axis of the stalk. It is only in the inferior portion of the stalk that the diacts are firmly united by means of synapticula.

The pentact-hypodermalia of the dermal skeleton are roughened only on the extremity of the proximal, and of the four transverse rays.

The autodermalia of the stalk are pentact pinuli in which the proximal ray is atrophied to the size of a small tubercle, while the freely projecting distal, on the contrary, has become a squamous pronged ray, 0·75 mm. or more in length. This increases in breadth outwardly, and, like the autogastralia of the discoid upper surface terminates in a knob-like thickening.

Genus 2. *Trachycaulus*, n. gen.

Only one species is referred to this genus.

Trachycaulus gurlittii, n. sp. (Pl. XXVI. figs. 4–9).

In the middle of the southern part of the Pacific (Station 289, lat. 39° 41′ S., long. 131° 23′ W.) there was trawled from a depth of 2550 fathoms and a red clay ground, the round stalk—12 cm. in length and 2 to 3 mm. in diameter—which is figured in Pl. XXVI. fig. 4. At the lower thinner end this stalk is slightly bent; it is otherwise straight, and is at the upper end broken across transversely. The surface of this hollow and tolerably firm stalk is covered with hairs. Although nothing remains of the sponge body belonging to the stalk, I cannot doubt from the structure of the fairly well-preserved dermal skeleton that we have to deal with a form closely related to the genus *Caulophacus*. Nevertheless the presence of a very peculiar rosette, and the absence of a form characteristic of the two known species of *Caulophacus*, even in the stalk, namely, of the frequent dispersalia, pronged discohexacts and discohexasters, prevent one from referring this specimen to that genus.

Greatly prolonged rod-like smooth diacts with rounded rough extremities form a firm lattice or ladder-like framework for the parenchyma, being bound together in parallel longitudinal rows by means of numerous transverse synapticula. Slender regular hexacts with smooth pointed rays occur in very various positions in the parenchyma, partly as integral parts of the lattice-work, partly only in external connection with it, or else quite freely on its surface.

Especially remarkable, however, on account of their size (=0·4 mm. in diameter) and singular form are the rosettes with short principal rays, upon each of which four long sickle-like terminal rays are placed. These forms occur scattered in the subdermal spaces between the hexacts which have just been mentioned (Pl. XXVI. figs. 7, 8). They recall the sickle rosettes of Oscar Schmidt. The inner portion of each terminal ray is very thin; outwardly the ray becomes gradually thicker, and bears on its extremity a more or less sharply hooked curve finally terminating in a backward bent point. Great variations occur in the form and size of this hook-shaped terminal portion which is sometimes quite irregularly bent, or else divided into two or three diverging points. Occasionally the four hooks which bend towards one another may fuse together.

There is a striking agreement between these forms and the "sickle rosettes" found by Oscar Schmidt in his *Hertwigia falcifera*, and figured by him in his Spongien des Meerbusens von Mexico, Taf. vi. fig. 8.

The dermal skeleton is composed of greatly prolonged hexact autodermal pinuli, in which the four transverse rays and the almost equally long proximal ray are simple,

smooth, or at most somewhat rough towards the pointed ends, while the delicate, freely projecting, fir-tree-like distal, which is two or three times longer, is beset with oblique outwardly directed prongs, and runs gradually to a point towards the outer extremity (Pl. XXVI. fig. 9).

The specific name I have given is in honour of my friend and former colleague in Graz, Professor Gurlitt.

Family III. Rossellidæ (Pls. LIII.–LXIX.; Pl. CII.).

Goblet- or beaker-shaped, with walls of varying thickness. Some rest either directly, or by means of a longer or shorter cylindrical stalk, upon a solid basis, others are rooted in mud by means of a basal mass of spicules. The external surface of the body is in some smooth and naked, in others armed with prominent pleuralia of varying length. The simple wide gastral cavity opens by a simple, round, more or less broad, oscular aperture, the margin of which is either naked or armed with a border or circlet of spicules. A special characteristic of the family is to be found in the fact that the distal ray of the dermalia *is always absent.* The dermalia occur as pentacts, tetracts, diacts, or even monacts. The gastralia have usually no freely projecting proximal ray, but in some cases they occur as fully developed hexacts.

Genus 1. *Lanuginella*, O. Schmidt (Pl. LIII. figs. 3–5).

1869. O. Schmidt, Mittheil. des naturw. Vereines für Steiermark, pp. 89, 261.
1870. O. Schmidt, Grundzüge einer Spongienfauna des atlant. Gebietes, p. 13.
1870. Sav. Kent, Monthly Micr. Journ., vol. iv. p. 247.

On a specimen of *Aphrocallistes* from St. Iago, one of the Cape Verde Islands, Oscar Schmidt found in 1870 some small spherical or ellipsoidal sponges of very elastic consistence, exhibiting a central cavity and a wide superior osculum. The outer surface, apart from spicules projecting here and there, was smooth—just as if varnished. The interior contained, according to O. Schmidt, prominent, smooth or finely spinose hexacts and simple oxydiacts with intersecting axial canals. In the outer layers, between the projecting needles, hexasters occurred in which each of the short principal rays was soon divided into four or five tuberculated branches, with transverse terminal plates. In the external dermal layer, and at the margin of the osculum, numerous sexradiate spicules occur, besides quadriradiate forms filling up the interspaces, and in part provided with sharply cornered knotted extremities. The smoothness of the outer surface seemed to be due to these four-rayed spicules.

Oscar Schmidt named the newly discovered Hexactinellid *Lanuginella*, because it

felt in the dried condition like a delicate woollen cocoon, and he added the specific name *pupa* on account of the shape already noted.

Only one species is known, *Lanuginella pupa*, O. Schmidt.

Lanuginella pupa, O. Schmidt (Pl. LIII. figs. 3–5).

In the vessels which contained the spirit specimens collected at Station 192, off Little Ki Island, I found, along with the large *Pheronema giganteum* and several specimens of *Polylophus philippinensis*, a number of oval and spherical structures 2 to 8 cm. in diameter, which turned out on closer inspection to be small sponges. Some of them were seen to be representatives of the *Lanuginella pupa* described by Oscar Schmidt,[1] while the others were young forms of *Polylophus philippinensis* which will be again referred to in the description of that form.

Lanuginella pupa, which occasionally grows on other Hexactinellida, has the form either of a completely closed smooth sphere, 2 to 3 mm. in diameter, or of a larger oval body with a somewhat flattened basal pole, and a round oscular opening about 1 mm. in breadth at the narrow upper end (Pl. LIII. fig. 3*a*, *b*, 4, 5).

On a longitudinal section of the larger ovoid specimen, one observes the central longitudinal gastral cavity, which is rounded off at the lower end, opening superiorly of course in the already mentioned osculum. Into this gastral cavity, which is lined by a subgastral trabecular network, the sack-like chambers open, either directly, or by means of canal-like efferent passages, and in this case the whole chamber layer is deeply folded. Between the smooth external network or dermal membrane and the folded chamber layer, there is an external or subdermal trabecular space, including a subdermal trabecular network and the subdermal spaces or afferent canals which penetrate the latter (Pl. LIII. fig. 5).

The parenchyma of the sponge contains, as O. Schmidt noted, medium sized oxyhexacts with long straight or slightly curved rays usually disposed radially and tangentially. Besides these principal forms, somewhat long, straight, or slightly curved oxydiacts occur, with a central axial cross, over which cruciate tubercles often project outwards as indications of the undeveloped rays. The disposition of these oxydiacts, which are often somewhat roughened terminally, is for the most part perfectly or approximately tangential, though, in some cases, it may be more or less divergent (Pl. LIII. fig. 5).

Between these large supporting spicules, we have to note the irregular scattered occurrence of small regular oxyhexacts with thin rays, and of numerous small discohexasters, in which each of the short, simple, cylindrical principals bears three, four, or five long diverging terminal rays with four to six-toothed, somewhat recurved, transverse discs at their extremities (Pl. LIV. fig. 3; Pl. LIII. fig. 5). Besides these, the

[1] Grundzüge einer Spongienfauna des atlant. Gebietes, p. 13.

parenchyma includes small rosettes in varying abundance and irregular distribution. One of these forms admits of the designation plumicome. Each of the six simple cylindrical principal rays bears a small plano-convex transverse disc, from which very fine S-shaped terminals arise in concentric rows in perianth-like fashion, very much as in the plumicome of *Polylophus philippinensis* represented in Pl. LIV. figs. 4, 6. Finally, there are very minute isolated rosettes, in which the short simple principal rays bear terminal transverse discs, having a thick brush-like fringe of somewhat long and very thin, radially disposed, knobbed terminals, like those in the rosette of *Rossella antarctica*, figured in Pl. LV. fig. 6.

I must further note that I was not able to find these two extremely delicate and inconspicuous forms of spicules in all the specimens which I examined, but only in a few.

The hypodermalia are simple smooth oxypentacts in which the unpaired proximal ray is always straight and somewhat long, and penetrates radially, like a nail, far into the parenchyma. The four tangential rays, intersecting at right angles, extend close beneath the dermal membrane, corresponding to the curvature of the general sponge surface in exhibiting a more or less marked inward curvature (Pl. LIII. fig. 5). In the quadrate meshes, which are formed by the apposition of these tangential rays of adjacent hypodermal pentacts, smaller pentacts of a similar type occur, with their tangential rays disposed parallel or diagonally to the tangentials of the larger forms. The dermal membrane itself contains exclusively numerous cruciate autodermal tetracts in which the rays are more or less roughened, somewhat narrowed towards the extremity, and ending finally in a conical point or in a slightly blunted fashion.

At the lower somewhat truncate basis of the egg-shaped sponge, the hypodermal oxypentacts are modified into long anchors by the thickening and more marked curvature of the tangentials, and by the decided thickening and elongation of the proximal tangential ray. These anchors are gradually more and more protruded from the sponge body, and may serve for the attachment of the sponge to its soft substratum. At the margin of the oscular aperture, I have sometimes observed long, pointed, rod-like needles, projecting radially to a more or less marked extent. These may be fitly regarded as marginalia.

In the evidently much younger and completely closed spherical specimen, the skin exhibits only hypodermal oxypentacts, and simple, strongly developed, cruciate autodermal tetracts. Internally, between the simple oxyhexacts, moderately long oxydiacts occur, with central nodes of intersection. Numerous discohexasters are also present (Pl. LIII. fig. 4).

Genus 2. *Polylophus*, n. gen.

1872. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. x. p. 137.
1873. Gray, *Op. cit.*, ser. 4, vol. xi. p. 234.
1873. Carter, *Op. cit.*, ser. 4, vol. xii. p. 361.
1875. Carter, *Op. cit.*, ser. 4, vol. xv. p. 118.
1877. Marshall and Meyer, Mittheil. Zool. Mus. Dresden, vol. ii. p. 261.

History.—Among the Hexactinellida which Dr. A. B. Meyer brought with him from Zebu (Philippines), Gray found in 1872 a comparatively large specimen which bore peculiarly disposed projecting tufts of needles on the posterior half, while the anterior extremity exhibited the wide aperture of a spacious gastral cavity. He compared this sponge with *Tetilla polyura*, O. Schmidt, while Carter, to whom it was handed over, at once detected a close relationship between this form and his *Rossella antarctica.* Gray therefore named it *Rossella philippinensis.* In 1873 Gray received some young buds of the same sponge, which were also obtained from Dr. A. B. Meyer. These were briefly described under the title *Psetalia globulosa*, Gray. In 1875, however, Carter published a detailed description with good figures of the form and structure both of the older specimen and the young buds (*Psetalia globulosa*, Gray). Both the general structure and the form of the spicules exhibited the close resemblance which those specimens bore to Carter's *Rossella antarctica.* Finally, Marshall and Meyer subjected these results to a close scrutiny in 1877, and described in detail the form and structure both of the entire sponge and of the various spicules.

The characteristic anchors found in the root and tuft-spicules were regarded by Marshall and Meyer not as homologous, but as analogous to the anchors in the tuft-spicules of *Euplectella*, *Semperella*, and *Hyalonema*, since the double cross was not found in these latter genera in the anchor head itself but further up in the shaft, so that the anchor teeth could not be looked upon as modified rays of hexradiate spicules. The nine distinct forms of spicules observed were found by Marshall and Meyer to be distributed as follows :—

A. Appendicular spicules :—
  1. Root-spicules of anchor-like form.
  2. Uniaxial spicules of the spicular wreath.

B. Spicules of the dermal skeleton :—
  3. Five-rayed spicules.
  4. Four-rayed spicules with tubercles.

C. Spicules of the parietes :—
  5. Gastral and facial five-rayed spicules.
  6. Six-rayed spicules.
  7. Uniaxial spicules.
  8. Rosettes.

D. Gastral spicules :—
  9. Small six-rayed spicules.

A young specimen, 5 mm. in diameter, in which the anchor-tufts were tolerably well developed, already showed the same spicular forms in a similar arrangement. A specimen preserved with its soft parts in spirit was found to be filled with small green and grey granules; some cell-nuclei were seen, and here and there a fragment of

siliceous matter or a drop of fat. On the outside of the sponge, in fine tangential sections, the small dermal pores could be detected in the quadrate meshes of the dermal skeleton.

This genus contains only a single species.

Polylophus philippinensis, (Gray) (Pl. LIII. figs. 1, 2; Pl. LIV.).

Some very young spherical or egg-shaped specimens of *Polylophus* (*Rossella*, Gray) *philippinensis*, Gray, were procured, along with *Lanuginella pupa*, O. Schmidt, near Little Ki Island (Station 192) from a depth of 129 fathoms. But besides these, numerous adult forms of the same species were collected near the Philippine Island, Zebu (Station 209, lat. 10° 14′ N., long. 123° 54′ E.), from a depth of 95 fathoms and a blue mud bottom. Some of these specimens were as large as a man's fist. They agree exactly with the careful description and figure given by Carter[1] and by Marshall. All the specimens exhibited a short, thick-walled, cup-form, with a wide round upper opening to the simple sack-like gastral cavity. Into the latter the efferent canals open with more or less wide round apertures, while the outer surface, covered with a fine lattice network, is elevated into numerous mammilla-like papillæ. From the summit of each of these radially disposed papillæ, which are especially thick and long on the lower surface of the body, a thin bundle or tuft of long hair-like siliceous spicules projects. On the upper and lateral surfaces these tufts of needles stand out radially, stiff and straight; on the median and basal papillæ, however, the siliceous hairs are much longer, and are apposed to one another to form a long, broad, loose root-tuft, by which the sponge is anchored in the mud (Pl. LIV. fig. 1). Very frequently, on the larger specimens, some or most of the papillary elevations are thickened terminally in a club-shaped fashion, and more or less markedly constricted at the base, so as to form pear-shaped appendages represented by a whole series of stages varying greatly in size and differentiation. Each protuberance begins as a small conical, subsequently pear-shaped, structure 2 to 3 mm. in length, and attains the size of a hazel nut. Fully developed forms exhibit lateral radial papillæ, and a basal radial tuft, while at the upper pole a circular aperture communicates with the central cavity. The whole form of a young *Polylophus* is thus assumed, and it remains connected to the mother organism merely by a few spicules. These give way of themselves, and a small form is set free which undeniably resembles the mother sponge in all essential points (Pl. LIV. fig. 1). It is noteworthy that almost all the larger specimens exhibit that tendency to form buds which has been repeatedly noted by earlier observers. Between the papillæ the external skin-covering appears to be as smooth as the concave interior surface of the gastral cavity. On the simple, somewhat sharp-edged oscular margin, there is no trace of a cuff-like marginal fringe of spicules.

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xv., pl. x. fig. 1.

The principal supporting spicules of the loose parenchyma consist of large or medium sized smooth oxyhexacts, with straight rays, and of straight or slightly curved oxydiacts, which are roughened towards their conically pointed extremities, and exhibit at their middle point four cruciate transverse tubercles, or an annular swelling, or at least the intersection of axial canals. These oxydiacts either lie isolated, or are for the most part disposed parallel to the surface. The larger and stouter forms are usually accompanied and ensheathed by a number of long thin oxydiacts or comitalia. As to smaller spicules, the parenchyma includes numerous regular oxyhexacts with more or less roughened rays, and also a large number of oxyhexaster forms which are very characteristic of this genus. In these the principal rays are comparatively long, simply cylindrical, or narrowed in a slightly conical fashion, and are always somewhat roughened terminally, where they divide into two or three short, diverging, conical terminals (Pl. LIV. fig. 5). When only two terminal rays are developed at the end of the principal, the planes of forking of the two rays in the same axis of the spicule are at right angles to one another. Finally, the parenchyma contains peculiar rosette forms, occurring in regular, but not very abundant distribution. These belong to the plumicome type, but are not so minute as those of *Lanuginella pupa*. They attain to about the same diameter as the above-described oxyhexasters, namely, about 0·1 mm. The short, cylindrical principal rays bear terminally a plano-convex transverse disc, from the outer convex surface of which several concentric whorls of S-shaped terminal rays arise. These go to form a perianth-like form with several whorls, enclosing a central funnel-shaped space (Pl. LIV. figs. 4, 6). The thinnest portion of these delicate S-shaped terminals lies near their origin, while the outer end becomes thickened in a somewhat club-shaped fashion, exhibiting, however, a slight attenuation at the extremity.

The *dermal skeleton* consists especially of hypodermal oxypentacts of variable size, in which the long proximal ray is always straight and radially disposed, while the four tangentials which go to form a quadrate lattice-work are usually curved gently inwards. Like the proximal ray, the tangentials frequently appear to be roughened near their conical extremities. Between these substantial pentact hypodermalia, the dermal membrane includes small cruciate autodermal tetracts in great abundance and in rectangular distribution. In these, the rough cylindrical rays, which are rounded off or even truncated at their ends, are curved slightly inwards, so that the whole spicule appears to be uniformly arched with the convexity outwards (Pl. LIV. figs. 2, 7). Sometimes, at the point of intersection of the four arms, an inward projecting boss or tubercle persists as an indication of the undeveloped fifth (proximal) ray. In a few of these dermalia, the fifth ray is actually developed, and exactly resembles the tangentials.

The *gastral skeleton* differs strikingly from the dermal. The hypogastral pentacts, as we should naturally expect, are wholly absent. Instead of them, there are

strongly developed, smooth oxydiacts, with slight curvature or twisting, and on these numerous oxyhexacts, of variable but not very considerable dimensions. In the latter the four tangential rays are tangentially disposed in the gastral membrane, while the internal, usually longer radial projects freely into the gastral cavity, and the external radial into the subgastral trabecular space. All the rays of the smaller gastral oxyhexacts run out gradually to a point, and are of approximately equal length, while in the larger gastral oxyhexacts the internal free ray is decidedly longer than the others, so that a dagger-form results. All the efferent canals are clothed internally with small delicate oxyhexacts, in which the inner radial ray projects to a greater or less distance into the canalicular space (Pl. LIV. fig. 2).

The long radially projecting spicules, which arise in a tuft from the terminal pole of each of the numerous lateral and basal papillæ, are smooth oxypentacts. Their interior end runs gradually to a point, while the outer terminates in a four-toothed anchor, in which the four cruciately disposed, strongly developed teeth do indeed at first arise at right angles to the shaft, but become more or less markedly curved inwards (Pl. LIV. fig. 9).

The basalia forming the root-tuft only differ from these lateral radially projecting pleuralia in their greater strength and length, and also in the fact that many of them, which have arisen from the curvature of the lower pleuralia, extend no longer quite radially, but are more or less markedly curved downwards (Pl. LIV. fig. 1).

A good general survey of the structure of this species can be obtained by making sections of the small, pear-shaped buds. A combined diagram representing this is given in Pl. LIII. fig. 2. It will be seen that the sack-shaped chambers, taken as a whole, make up a much folded layer, which forms the boundary between the water-passages leading from the external skin and those leading into the common gastral cavity. The circular oscular aperture of the gastral cavity appears at a later stage at the broad distal pole of the pear-shaped bud. The bud at the same time pushes itself outwards on the bundle of pleuralia belonging to the papilla. It forms for itself papillæ with pleural and basal tufts of spicules. Finally it becomes detached and rooted in the mud.

As in the above-described genus, *Lanuginella*, the basalia (and pleuralia also) are nothing but long drawn-out and protruded spicules of the hypodermal pentact series. This may be presumed by comparing the young basalia or pleuralia with the adjacent hypodermalia, but the fact is distinctly demonstrated by studying sections of young, spherical or oval specimens, 2 to 5 mm. in diameter (Pl. LIII. figs. 1*a*, *b*) (probably developed from ova), which were found in the same glasses as the Hexactinellids from Station 192, Little Ki Island. At the lower, often somewhat truncate pole, opposite the oscular aperture, between the ordinary hypodermal pentacts, other forms occur in which the four tangential rays do indeed lie in the dermal membrane, but are bent more markedly inwards than the others, and are beginning to resemble the anchor-teeth of the

basalia, while others of similar structure are bent somewhat outwards above the level of the skin, and others, again, especially in somewhat larger sponges, are drawn out into true anchors, which exactly resemble the basalia of the adult specimens.

Genus 3. *Rossella*, Carter (Pl. LV., and woodcut, fig. 4).

1872. Carter, Ann. and Mag. Nat. Hist., vol. ix. p. 409 (*Rossella antarctica*).
1872. Bowerbank, *Op. cit.*, vol. x. pp. 58–61.
1872. Gray, *Op. cit.*, vol. x. p. 134 (*Rossella philippinensis*).
1873. Carter, *Op. cit.*, vol. xi. p. 275.
1873. Gray, *Op. cit.*, vol. xi. p. 234 (*Pectalia globulosa*).
1873. Wyville Thomson, Depths of the Sea (*Rossella velata*).
1873. Carter, Ann. and Mag. Nat. Hist., vol. xii. p. 361.
1874. Gray, *Op. cit.*, vol. xiii. p. 284.
1875. Carter, *Op. cit.*, vol. xv. p. 113.
1875. Willemoes Suhm, Zeitschr. f. wiss. Zool., vol. xxv. p. 25.
1876. Marshall, *Op. cit.*, vol. xxvii. p. 113.
1877. Zittel, Abhandl. d. II. Cl. k. baier. Akad. d. Wiss., vol. xiii.
1877. Marshall and Meyer, Mittheil. Zool. Mus. Dresden, vol. ii. 261.

History.—Among some Antarctic sponges which were dredged by Captain Sir James Ross during his voyage of discovery and research in the Southern and Antarctic region in 1839–43 (lat. $74\frac{1}{2}°$ S., long. (?), and lat. $77\frac{1}{2}°$ S., long. 175° W., from a depth of 300 fathoms), Carter found, in 1872, two remarkable and hitherto unobserved forms of siliceous elements—the one a five-rayed spicule in which the longer ray, measuring about 1 cm. in length, ran out to a fine point at one extremity, but passed at the other into four approximately cruciate, straight or slightly bent transverse arms, disposed at right angles; the second, a four-toothed anchor with a long (at least 4 cm.) shaft and cruciately disposed, somewhat strong, recurved teeth, which ran out into simple points. In some anchors the straight shaft was continued to the other side of the anchor teeth, so that with the projecting point the entire structures became hexradiate.

While all parts of the anchors were smooth, the rays of the five-rayed spicules, which are likewise round, were thickly beset with very fine microspines; on the four pointed transverse arms, however, numerous larger slightly bent tubercles also occurred with their free points turned away from the intersection of the arms. Although the sponge bodies to which these spicules belonged were not discovered, it seemed certain that the two kinds of spicules belonged to one and the same sponge, which Carter named *Rossella antarctica.* This procedure certainly seemed at first somewhat rash, and Bowerbank did not fail to declare his disapproval.[1] Further discoveries, however, soon served to justify Carter's opinion.

In the same year, Gray found a second species of the same genus among the sponges

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. x. p. 58.

which A. B. Meyer had sent to the British Museum from Zebu, one of the Philippine Islands, and named it *Rossella philippinensis*.[1] It was a longish oval specimen as large as a walnut; its transversely truncated upper end bore the wide round orifice of a deep central cavity, while, from the inferior half of the otherwise smooth body, a cylindrical bundle of long siliceous spicules ran out radially at different distances from one another, and then bent downwards into a tuft. That this sponge belongs to the genus *Rossella* was confirmed by Carter in a communication addressed to Gray; the four-armed spicules of the skin with their somewhat backwardly bent branches were to him sufficient proof of the fact. Yet, as Carter remarks, this form may be readily distinguished from *Rossella antarctica* by the fact that the arms of the outer spicules are smooth, and not beset, as in the latter, with delicate microspines.

Carter has also directed attention to the great similarity between the spicules of *Rossella philippinensis* and those found in the genus *Crateromorpha*, Gray.

Wyville Thomson,[2] gave an account of a third species of *Rossella*, which was dredged in 651 fathoms, to the west of the opening of the Strait of Gibraltar. The oval body of this remarkably elegant sponge, described as *Rossella velata*, bears superiorly (as in *Pheronema*) a single large round osculum, but instead of forming a cup uniformly lined with a netted membrane, the oscular cavity divides at the bottom into a number of branching passages as in *Pheronema annæ* described by Leidy.

"A delicate outer veil about a centimetre from the surface of the sponge is formed by the interlacing of the four secondary rays of large five-rayed spicules which send their long shafts from that point vertically into the sponge body. The surface of the sponge is formed of a network of large five-radiated spicules arranged very much as in *Pheronema*."

In a paper on Sarcohexactinellidan Sponges,[3] Carter has noted that in *Rossella velata* and *Rossella philippinensis* "the minute equi-armed hexradiate spicules pass from the equi-armed hexacts with bifurcated and pointed extremities to the same with capitate extremities, and lastly into an undescribed form where the ends of the arms are terminated by a small conical tuberculated inflation presenting a short straight spine on the apex, which spine is surrounded by almost innumerable linear filaments rising each from one of the tubercles, attaining various heights and bending outward like the expanded petals of a tubular flower, forming one of the most exquisite objects in nature. It might be named 'pappiform' flexed and simple in contradistinction to another kind in which the filaments are straight and capitate."

The generic diagnosis of *Rossella* was given by Carter in his Review of the Hexactinellida[4] in the following words:—"Rosette few- or many-rayed: rays few of equal length straight and pointed or spinocapitate; or multitudinous, of unequal length,

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. x. pp. 137, 138.
[2] The Depths of the Sea, p. 418, 1873.
[3] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xi. p. 279.
[4] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 361.

without heads, flexed outwards and arranged *en fleur-de-lis;* pappiform, or sometimes many-rayed with rays straight and capitate. Anchoring spicules all smooth, stout and terminating respectively in heads of *four* equally stout recurved spines or hooks."

In 1875 Carter happened to discover among the treasures of the British Museum "a glass jar containing two small specimens of the veritable *Rossella antarctica* dredged up by Sir J. Ross in 300 fathoms 74½° S. lat.," longitude not given.

"The general form of this sessile or fixed sponge was sack-like (compressed) with the upper end truncated and open and the lower one conical and closed. External surface uniformly cribellate and monticular, covered by a thin layer of spicular lattice-work and surrounded by three forms of projecting spicules:—viz., (1) stout linear smooth nearly straight fusiform acerate spicules, finely pointed at each end, constituting an erect beard round the aperture; (2) anchoring spicules which increase in number, size, and length towards the lower or conical end; (3) crucially headed or veil spicules projecting chiefly from the monticules over every part of the external surface but the aperture, consisting of a shaft whose pointed or inner end is fixed in the sarcode of the body, and whose free or outer one is terminated by four long arms spread out horizontally so as to intercross with those of its neighbours, and thus form a general veil-like covering separated from the body by the length of the shafts between the body and their heads respectively; shaft smooth or only microtuberculate over the imbedded end, arms more or less flexuous, fine-pointed, parting from the head of the shaft at different angles, covered almost throughout with minute spicules closely approximated, amongst which here and there is a much larger spine curved and inclined outwards or from the head of the shaft."

Among the seven other forms of spicules which Carter has described from the body of the sponge the following are especially noteworthy:—

"(1) Very minute sexradiate rosettes with numerous straight capitate rays, and (2) sexradiate rosettes with thick sparsely spined arms, whose inflated ends support four or more indistinctly capitate rays; rays microspined, thick at first, then becoming finely attenuated and terminating in a hardly perceptible capitate inflation; rays at first straight and parallel like the prongs of a dinner-fork, becoming more or less divergent towards their extremities."

In his systematic review published in the year 1875,[1] Carter placed the genus *Rossella* along with *Crateromorpha* in a group called the Rosettifera within his family of the Sarcohexactinellidæ.

The characteristics which Marshall[2] in 1876 assigned to the genus *Rossella* ran thus: —"Monozoic, root-tufts springing from papilla-like hillocks on the parietes, dermal skeleton composed of five-rayed spicules. In *Rossella antarctica* a peristomal spicular wreath (whether present in the other species is doubtful)."

Character of the Genus.—Thick-walled, ovoid or cask-shaped goblets, with a superior,

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xvi. p. 199.

[2] *Zeitschr. f. wiss. Zool.*, Bd. xvii. p. 127.

circular, smooth-margined opening to the deep saccular gastral cavity. A group of diact and pentact pleuralia, whose tangential rays form a kind of veil, project radially from each of a number of small, regularly disposed, rounded elevations of the surface. In the neighbourhood of the simple unarmed oscular wall a number of strong isolated diacts project upwards. Between the dermal layer and the sieve-like gastral layer which stands above it the soft parts form a deeply folded plate with alternating inhalent and exhalent radial funnel-shaped canals.

The parenchyma contains oxyhexasters with very short main rays and various discohexasters. The spicules of the dermal membrane are almost exclusively pentacts.

1. *Rossella antarctica*, Carter (Pl. LV.).

Of the two species of *Rossella* hitherto known, viz., *Rossella antarctica*, Carter, and *Rossella velata*, Wyville Thomson, the former is represented in the Challenger collection by numerous specimens, which vary considerably in size, and were collected at four different stations.

Several specimens, from 2 to 4 cm. in height, growing on small fragments of bivalve shells and similar objects, were dredged to the south-east of Prince Edward Island (Station 145, lat. 46° 43′ 0″ S., long. 38° 4′ 30″ E.), from a depth of 140 fathoms, and volcanic sand ground. Numerous specimens of very various dimensions, up to 30 cm. in length and 15 cm. in breadth, were dredged to the south of the Kerguelen Islands (Station 150, lat. 52° 4′ S., long. 71° 22′ E.), from a depth of 150 fathoms, and a coarse gravel ground. Other forms of almost equal dimensions were obtained in Christmas Harbour, Kerguelen, at various depths, from volcanic mud ground. All these more or less well-preserved spirit specimens were attached at their base to stones, either directly or by means of small processes. Finally, several specimens, attaining a length of 20 cm., were trawled to the east of Buenos Ayres (Station 320, lat. 37° 17′ S., long. 53° 52′ W.), from a depth of 600 fathoms, and a green sand ground. These also were attached, either directly or by means of small processes and prolongations, to stones or other solid bodies.

The general form of this sponge may be described as barrel- or keg-like, or else as resembling an elongated pear. The lower, sometimes somewhat narrowed, solid end is either attached over its entire breadth to some large solid body, or is fastened by short lateral processes of irregular form to various smaller objects. I have never found the peculiar loose root-tuft which Carter represents in his diagrammatic figure;[1] but I have noticed such a structure on one of the two original specimens preserved in the British Museum, and it is quite possible that this modification, as

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xv. pl. x. fig. 4.

present on one of the specimens examined by Carter, is conditioned by the somewhat looser nature of the substratum.

On the middle of the upper end there is a sharp cornered, round, oscular aperture, leading directly into the equally wide, deep, gastral cavity, which has a cylindrical form, and is rounded off in the blind lower portion. The cavity occupies about a third of the entire diameter of the body (Pl. LV. fig. 1). The whole external surface of the body is beset with numerous regularly distributed, but somewhat undefined, papilla-like elevations, which attain a height of 2 to 4 mm., and occur, according to the size of the sponge, at variable distances of 2 to 10 mm. or more. From each of these papillæ a tuft of radially directed pleuralia projects. Of these spicules some run out to a point, while others, at a distance of 3 to 8 mm., give off transversely disposed tangentials, which go to form a veil over the surface of the sponge. Near the oscular opening the papillæ become less conspicuous and more crowded, but cease altogether close to the oscular margin. Instead of them, a large number of isolated pointed radial spicules occur, which form a sort of marginal fringe, not round the sharp edge of the osculum, however, but at a slight distance further out. Nor do they form a sharply-defined, cuff-like fringe. I observed similar prostalia round the oscular margin of the original specimens described by Carter, but besides these some more transversely directed needles, forming a sort of flat collar, which I did not find developed on the Challenger specimens. In the uniformly even, but fine velvet-like sieve-network of the gastral membrane, numerous round apertures could be seen. These measure about 2 mm. in diameter, and occur in uniform distribution at intervals of 2 to 3 mm. over the whole gastral surface of the sponge. They represent the main efferent canals, which alternate with the afferent passages, and are uniformly disposed at right angles to the lateral wall. In cross sections the parenchyma is seen as a deeply folded layer (Pl. LV. figs. 1, 7).

The principal supporting spicules of the loose parenchyma consist of longer or short, straight or gently curved diacts, which vary in strength, and are either isolated, or are irregularly disposed in strands throughout the body. A strongly-developed beam is usually ensheathed by a layer of thin comitalia. Most of these diacts are smooth except at the extremities, which are rough or tubercled, and either end in conical points or are somewhat rounded off and occasionally club-shaped. The central portion usually exhibits an annular thickening, or four cruciately disposed tubercles. Even when the middle is quite smooth and without projection, a trace of the axial cross is often apparent. Between the strands of diacts, there is here and there a tolerably abundant occurrence of rough or even spinose regular hexacts of less than medium size. Numerous minute, rough, regular hexacts also occur. There is a very abundant occurrence of small rough oxyhexasters with a varying number of rays divided into terminals. Frequently only one ray is thus split, but usually three or four, and rarely all the six. The forking of the principal ray always takes place at a slight distance from the frequently thickened node of inter-

section, so that the whole spicule comes sometimes to look like a many-rayed star. The principal ray is usually divided only into two, but not unfrequently three diverging terminals are thus produced, and less frequently more than three. Besides these oxyhexasters, there is a very abundant occurrence of various discohexaster forms, which are in part somewhat smaller than the oxyhexasters just described, but in part larger. These also exhibit short simple principal rays, and comparatively long divergent terminals, with small four- to six-toothed, transverse and somewhat recurved terminal plates. The number of terminal rays varies very considerably in the smaller forms; there are usually three to six or even more on each principal ray (Pl. LV. figs. 6, 15).

In the larger discohexasters, which are also rather divergent in form, the simple cylindrical principals are somewhat longer, and divide into from three to six S-shaped thin terminals, which are grouped together in a slender perianth-like bundle (Pl. LV. fig. 14). Carter has already noted this peculiar form of rosette as characteristic of the species. Of quite isolated and exceptional occurrence in the parenchyma is the small simple discohexact, figured in Pl. LV. fig. 8. It may possibly not belong to this sponge, but have originated as an intrusion from without.

The dermal skeleton includes, in the first place, medium-sized hypodermal oxypentacts, in which the rays are for the most part smooth, and only roughened at the conically pointed ends. The four cruciate tangential rays are rarely disposed exactly in the dermal membrane, but are usually somewhat below it, or pushed out beyond, though in both cases parallel. In some cases the four tangential rays do not intersect at right angles, but are all pushed together to one side, as we shall afterwards have to note in regard to the pleural prostalia. In much closer connection with the dermal membrane are the small, finely spinose, autodermal pentacts. In these the four cylindrical tangential rays, which are tolerably straight, and at most gently incurved, with rounded or somewhat conically pointed ends, form a rectangular meshwork within the dermal membrane. The proximal radial ray, which has approximately equal length and similar characters, projects into the subdermal space (Pl. LV. figs. 2, 3). The undeveloped sixth distal radial ray is almost always represented by a rounded tubercle or knob. In rare cases, especially near the base, I found, between the pentacts, isolated cruciate tetracts of similar form and equal size (Pl. LV. fig. 4).

The gastral skeleton, which lines the inner surface of the gastral cavity, essentially resembles the dermal, but differs in this, that the finely spinous gastralia, whose tangential rays extend within the gastral membrane, are not pentacts, but well-developed hexacts (Pl. LV. fig. 5) in which the internal radial ray projects into the gastral cavity, and gives the internal surface that peculiar velvety appearance which we noted above.

The radial tufts of pleural prostalia, which project from the papillæ over the whole external surface of the body, consist of four to eight spicules which project for 1 to 2 cm.

The strong, smooth, principal radial ray, which is always pointed towards the interior of the sponge-body, is either simply pointed at the outer extremity, so that simple oxydiact forms result, or gives origin to four exactly tangential rays (6 to 10 mm. in length), which do not, however, intersect at right angles, but form with one another three acute angles of 40° to 50°, so that the two outermost rays together form an angle of 100° to 150°, rarely of 180° (Pl. LV. figs. 9, 13). As from three to five of these pentacts are grouped together in a tuft, and so disposed that the points of the tangential rays meet at an angle, a most beautiful veil is formed, which spreads over the sponge at a distance of 5 to 12 mm. from the surface. Besides these peculiar pentacts, each tuft of parietal prostalia includes several of the above-mentioned radial diacts, which project freely for 3 to 6 mm. beyond the surface of the pentact-veil. Near the oscular margin the pentact prostalia disappear, and the oxydiacts become more prominent. The latter are sometimes so numerous and closely grouped that they form a thick wreath of externally directed and pointed spicules (Pl. LV. figs. 1, 7). The long, smooth, radial ray of the pleural pentacts, is, as regards its surface, in marked contrast to the four tangentials which spring from its outer extremity, and run out in a straight or slightly curved course to a gradually narrowed point. As Carter has carefully described, the whole surface of these tangentials is so thickly and uniformly beset with fine pointed tubercles that it presents a thoroughly rough appearance. Between these small tubercles, but at greater intervals, strongly developed spines project obliquely outwards like the prickles of a rose. They occur with tolerable uniformity, but without recognisable law, and gradually decrease in height towards the narrowed end (Pl. LV. figs. 9, 13).

The spicules of *Rossella antarctica* undergo peculiar modification at the base, where the sponge is either attached directly to some solid body, or fixed by means of processes to various smaller objects. The parenchyma contains, in the first place, very abundant small discohexasters, like those represented in Pl. LV. fig. 6, but with more numerous and shorter terminals rising from comparatively broad basal discs.

We have also to note that here all the longer spicules, and especially the long diacts, exhibit terminally a club-shaped thickening with large tubercles, instead of the small points or roughnesses which occur elsewhere. Finally, in the region where the sponge comes into contact with the substratum, manifold modifications occur in the form of outgrowths, fusions, and not unfrequently irregular reticulations, similar to those represented in Pl. LXIV. fig. 3, from *Rhabdocalyptus mollis*. Such modifications only occur where some irritation is exerted on the sponge through contact with foreign bodies.

Whether the spicule figured in Pl. LV. fig. 12, which I found isolated in the basal portion of a *Rossella antarctica* (Station 320), really belongs to the sponge or is a foreign intrusion, I cannot determine.

2. *Rossella velata*, Wyville Thomson.

A beautiful species of *Rossella* was dredged by Dr. Gwyn Jeffreys in the Atlantic, off the mouth of the Strait of Gibraltar, from a depth of 651 fathoms, and is figured

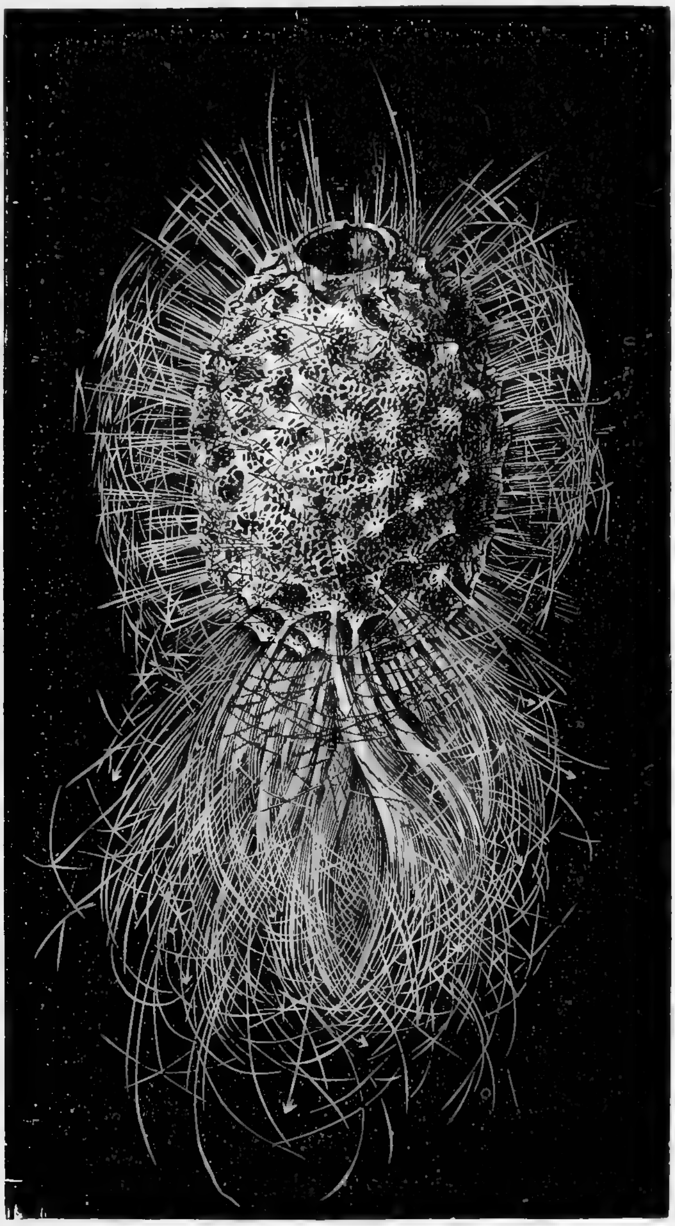

FIG. 4.—*Rossella velata*, Wyville Thomson.

and shortly described by Wyville Thomson.[1] Of this form the Challenger Expedition procured no specimen, but I obtained for investigation a specimen dredged by Wyville

[1] Depths of the Sea, pp. 418, 419.

Thomson on the "Porcupine" expedition, off the Strait of Gibraltar, and very probably the same form as was figured in the Depths of the Sea, p. 419. To this dried specimen the following description refers.

In contrast to the cylindrical or barrel-like shape of most of the specimens of *Rossella antarctica*, Carter, the form of *Rossella velata*, Wyville Thomson, is perfectly ovoid, 6·5 cm. long, by 4·5 broad. The superior pole exhibits a circular, sharp-edged aperture, 1·6 cm. in diameter,—the opening of the equally broad, cylindrical, gastral cavity (4 cm. in depth) into which the efferent canals open. The roundish apertures of the latter are especially wide in the blind basal portion of the cavity, and become gradually narrower towards the upper end. The external surface of the body is not uniformly smooth, nor beset merely with minute, sharply-defined papillæ, as in *Rossella antarctica*, but is rather to be described as hillocky, with numerous gently convex protuberances, from 5 to 6 mm. in breadth, and not sharply defined from the reticulate, connected, intervening depressions. They are distributed over the whole surface, with some regularity, at intervals of about 10 mm. between the summits. The network of beams, which extends radially in relation to these projecting eminences, is doubtless covered during life by the fine rectangular lattice-work of the smaller dermalia. The whole external surface of the sponge is covered by the greatly-developed system of most beautiful prostalia, which project radially, in small groups, from the apices of the hillocky elevations. These tufts of pleuralia consist of simple pointed diacts and pentacts, in which the four tangential rays arise at right angles to the radial ray, at a distance of about 10 mm. from the surface of the body. They intersect, not at acute angles, but in a perfect cruciform fashion; they are also directed mutually at right angles. At the upper end of the sponge, near the oscular margin, only the radially disposed, long oxydiacts persist, forming a marginal fringe, which attains the conspicuous length of 3 to 4 cm. At the lower pole of the sponge-body, on a flat surface measuring 6 to 7 square cm., thick tufts of spicules arise from the apices of hillocky elevations. The tufts bear twenty or more basalia, 5 to 8 cm. in length, and taken together form a loose basal tuft. On most of these long basalia one can recognise, even with the naked eye, at the outer extremity, a small four-rayed anchor.

The parenchyma contains, as in *Rossella antarctica*, medium-sized oxyhexacts and oxydiacts, which are frequently roughened towards the pointed extremities. The middle portions of the oxydiacts are either smooth, or provided with an annular swelling or with four cruciate projections—traces of the undeveloped rays. Small oxyhexasters with short principal rays, each bearing two long divergent terminals, are very abundant. Between these there is a somewhat abundant, but locally variable occurrence of discohexasters similar to the above, but with toothed, somewhat incurved, transverse discs at the ends of the terminal rays, and also of discohexasters in which the

short, somewhat terminally expanded principal rays, bear several (three, four, or more) long terminals with toothed transverse terminal discs. The rosettes with slender groups of S-shaped terminals, which occur abundantly in *Rossella antarctica* (Pl. LV. fig. 14), are absent in this species, and their place is taken by small plumicomes, in which the short principal rays bear broad, plano-convex, transverse discs, from the convex external surface of which several whorls of fine S-shaped terminals arise in perianth-like fashion, as in the plumicomes of *Polylophus philippinensis* (Pl. LIV. figs. 4, 6).

The dermal skeleton contains, besides simple medium-sized hypodermal oxypentacts, strong rough or toothed pentacts with rounded or truncated, straight, cylindrical rays, such as occur in *Rossella antarctica.* In these forms there is a very constant occurrence of a knob-like or hemispherical projection at the distal side of the point of intersection—the evident rudiment of a sixth distal radial ray.

The gastral skeleton does not differ essentially from that of *Rossella antarctica.*

The long basalia, which are always smooth inside the body, but sometimes have lateral barbs outside the body, bear on their extremities four markedly recurved, simply pointed anchor-teeth, in which the central canal can be detected.

Genus 4. *Acanthascus*, n. gen. (Pls. LVI., LVII.).

Thick-walled goblet-shaped forms firmly attached at their base. The deep simple gastral cavity opens superiorly in a round, smooth-margined osculum. From the external surface of the body isolated, or more rarely grouped oxydiact pleuralia project radially. The parenchyma contains oxyhexasters with short principal rays, and various discohexasters. The dermalia are small roughened tetracts and pentacts.

1. *Acanthascus grossularia*, n. sp. (Pl. LVI.).

In the vicinity of Possession Island (Station 148, lat. 46° 47′ S., long. 51° 37′ E.), from a depth of 210 fathoms, on a hard ground of gravel and shells, an egg-shaped sponge was dredged, which in size and form resembled a large gooseberry. The lower pole had been broken off. At the superior pole there is a circular, smooth-margined oscular aperture, leading into a saccular gastral cavity 2·5 cm. in depth. Through the smooth internal skin of the cavity the efferent canals can be seen, 1 to 2 mm. in width; the larger afferent canals were, in the same way, visible through the external skin. From the outer surface, which is on the whole uniformly arched and smooth, numerous simple smooth and pointed needles, irregularly distributed, project obliquely outwards and upwards, and attain a length of 5 to 10 mm. Near the oscular opening these prostalia are

especially long and strongly developed, and have an approximately perpendicular disposition (Pl. LVI. figs. 1, 2).

The principal spicules of the parenchyma are large and medium-sized oxydiacts of varying length, which are tubercled towards the pointed ends, and are in the middle either smooth or provided with an annular swelling, or with four projecting bosses or ray-rudiments. They occur either in isolated distribution or in strands which vary in direction. They are, for the most part, parallel to the outer and inner bounding surface, or disposed radially to the same. Some especially large and thick diacts lie longitudinally near the gastral surface. I have hardly ever observed large hexacts, though here and there isolated medium-sized regular oxyhexacts occur, with slightly spinous rays. Small hexact forms also occur with smooth rays. On the other hand, all through the parenchyma, in tolerably uniform though scattered distribution, oxyhexasters occur with short principal rays, and with a varying number of long divergent smooth terminals, two of which are usually borne at the end of each principal ray (Pl. LVI. fig. 7). Besides these, we have to note the less abundant occurrence of small discohexasters with four or more long, tolerably straight terminals, each provided with a small four-toothed, terminal, transverse disc (Pl. LVI. fig. 9). Not unfrequently, also, somewhat larger discohexasters occur, in which each of the short simple principals bears from three to six or more slightly S-shaped terminals. These are united in a usually somewhat slender, perianth-like bundle, and are terminally roughened on their outer extremities, which always bear a four-toothed disc (Pl. LVI. figs. 3, 4). In quite isolated distribution small discohexasters occur, with moderately short principal rays terminally expanded into a disc, which bears on its outer convex surface a large number of delicate diverging terminals, forming a brush-like tuft, and bearing on their extremities minute four-toothed discs (Pl. LVI. figs. 10, 11).

In the dermal skeleton, medium-sized, smooth hypodermal oxypentacts occur, in which the proximal ray is radially disposed, while the four long tangentials, intersecting at right angles, follow the superficial curvature of the sponge in being slightly curved inwards.

In the large rectangular meshes of these pentact hypodermalia, numerous autodermal pentacts and tetracts occur in the dermal membrane. They agree exactly with the small rough dermalia in the genus *Rossella*. It has to be noted, however, that the number of tetracts exhibiting a simple right-angled intersection of rays (Pl. LVI. fig. 5) is in proportion to that of the otherwise very similar pentacts (Pl. LVI. fig. 6) decidedly greater in this *Acanthascus* than in *Rossella* (Pl. LVI. fig. 2). These rough dermal pentacts when compared with those of the genus *Rossella* exhibit a slight divergence in this, that there is no boss- or knob-like rudiment of the sixth distal ray. The tetracts are also without any such rudimentary ray (Pl. LVI. figs. 5, 6).

On the inner side of the body-wall, the special gastral skeleton is represented by a

sheath of finely spinous oxyhexacts (Pl. LVI. fig. 12), in which the radial ray, directed towards the centre, projects into the lumen of the gastral space, while the opposite radial ray intrudes into the subgastral space, and the tangential rays, intersecting at right angles, lie in the gastral membrane (Pl. LVI. fig. 2).

The medium-sized oxydiacts, which project freely from 3 to 5 mm. outwards and upwards beyond the external surface, are unfortunately for the most part broken. They occur somewhat irregularly and are not very numerous, being probably to a large extent lost. I have not discovered any pentact prostalia similar to those which occurred in *Rossella*, and must therefore conclude that they are absent.

2. *Acanthascus dubius*, n. sp. (Pl. LVII. figs. 8–13).

To the south of Puerta Bueno, in Patagonia (Station 310, lat. 51° 27′ 30″ S., long. 74° 3′ W.), from a depth of 400 fathoms and a blue mud ground, a Hexactinellid was trawled, of which unfortunately only the basal part, which had grown on the ramifications of a colony of *Lophohelia*, was preserved, and that imperfectly. What remains is about the size of a man's fist, and represents the basal portion of a cup-shaped sponge, which in its entirety must have been about four times as long. The remnants of the external surface still preserved seem to be approximately smooth, but it is impossible to decide as to the presence or absence of elevations with freely projecting spicules. On the interior gastral surface of the wall (2 to 3 cm. in thickness), there are large round apertures, 3 to 8 mm. and more in diameter,—the openings of the efferent canals into the gastral cavity. The latter must have been at least 5 cm. wide.

The tissues are a good deal macerated, so that the skeleton is somewhat loose, and would have altogether fallen to pieces were it not that the larger spicules of the parenchyma are thoroughly bound together by means of synapticula and siliceous cementing masses. The somewhat thick parenchymal skeleton consists of numerous oxydiacts, either isolated or in strands, and often bound together as above noted. They vary in length, but attain no considerable thickness. Especially in the lower portions of the sponge which had grown on the *Lophohelia*, the parallel, straight, rod-like spicules are very thoroughly bound together by numerous transverse synapticula (Pl. LVII. fig. 12). The terminal portions of these spicules are usually tuberculated or rough, and are either gradually narrowed or conically pointed, or else rounded off, and sometimes even somewhat clubbed. The regular oxyhexacts which occur here and there between the numerous long diacts, are under medium size, either spinous or smooth, and in rare instances exhibit thickened or tubercled central nodes (Pl. LVII. fig. 13). Here and there small smooth oxyhexacts occur, with slender, straight rays, which do not exceed in size the numerous rosettes about to be described. Among these there is a special abundance of oxyhexasters

with very short principals, and comparatively strong and long divergent terminals, which vary in number from two to four, though they are generally three (Pl. LVII. fig. 8). By the extreme shortening of the principals, these terminal rays are often drawn so near to the central node, which is usually thickened in such cases, that the whole spicule appears as a many-rayed star round the central node. Were there not countless transitional forms of hexasters with six distinct principals, leading up to the many-rayed stellate form, there might be real doubt as to the nature of the latter. As it is, however, the stars can be without difficulty traced back to the triaxial type. I observed the isolated occurrence of discohexasters with short principal rays, and with a varying number of long terminals. As figured on Pl. LVII. figs. 9, 10, 11, their resemblance to similar structures in *Acanthascus grossularia* is evident.

As to the dermal skeleton, I have observed some smooth hypodermal oxypentacts of medium size, and numerous smaller dermal pentacts, with straight, rough rays which are conically pointed at their extremities, or else rounded off and even truncated. In the latter form there is an almost constant occurrence of a small boss or elevation representing the undeveloped sixth distal ray. On the other hand, I have never observed any cruciate tetracts. On the inner gastral surface numerous hexacts occur, with straight, rough rays, similar to the above-described dermal pentacts.

The marked resemblance in form, structure, and skeleton between the basal portion of this form, and the corresponding part of *Acanthascus grossularia*, seems to justify the assumption that the upper portions must also have been like one another. We would therefore expect the presence of oblique projecting pleural oxydiacts and a simple oscular margin.

3. *Acanthascus cactus*, n. sp. (Pl. LVII. figs. 1–7).

Among the dried specimens of Japanese sponges which Dr. Döderlein brought with him from Enosima, there was a pear-shaped, somewhat laterally compressed, thick-walled form, figured in Pl. LVII. fig. 1. This Hexactinellid resembles a sack or beaker in form, is 9 cm. long by 5 cm. broad, and 4 cm. thick. By its narrower end directly, and also by means of several basal projections, 3 to 4 mm. in diameter, the sponge is attached to a firm substratum. The superior aperture of the simple gastral cavity, which is about 3 cm. in width, is surrounded by a somewhat sharp-edged smooth margin. On the lower end also, between the basal attaching protrusions, there is an irregularly contoured aperture about 8 mm. in diameter, but possibly the result of subsequent damage.

The external surface of the body is beset with conical elevations varying in height up to 8 mm. They are largest in the middle of the sponge, and decrease in height towards the oscular margin. They occur at intervals of 1 to 2 cm., and bear on their

apex a tuft of divergent pointed spicules, which project freely for 2 cm. or more. The general form of the body, and the occurrence of these spherical elevations at approximately equal intervals on the outer surface, and especially the tufts of spicules projecting from their apices, produce a close resemblance between this sponge and certain prickly cactuses. I have for this reason given this form the specific designation *cactus*.

While the whole external surface of the body is covered with a fine meshed dermal network, the simple, smooth internal surface is covered with a firm gastral membrane, which is abundantly perforated by numerous round apertures, about 1 mm. in breadth.

The parenchymal skeleton exhibits numerous thickly distributed oxydiacts in variable disposition. These are, for the most part, surrounded by oxydiact comitalia of but slight development. Near the conically pointed ends these diacts are usually somewhat rough, but are otherwise smooth. In the middle they are usually quite smooth, though less frequently exhibiting a median thickening, or else four cruciate or two opposite elevations. Besides the slender comital oxydiacts, numerous isolated spicules of the same sort occur.

I have not observed in the parenchyma any simple hexacts of medium size, but only small, slender, isolated oxyhexacts, resembling in size the rosettes about to be described.

There is an abundant occurrence of the familiar oxyhexaster forms with short principal rays, and long, smooth, diverging terminals, which are here somewhat strongly developed (Pl. LVII. fig. 3). Between these, spicules occur of similar size and structure with six undivided rays, each of which exhibits, at the same distance from the common node of intersection as the point where the principals divide in the oxyhexasters, a sharp flexure, succeeded by a small curve, and finally by a straight portion continued on to the point. Spicules thus modified may be regarded as reduced derivatives of the above described oxyhexasters.

There is besides a not unfrequent occurrence of irregular rosettes, which seem at first sight to be quite distinct from the Hexactinellid type of spicule, since they almost always exhibit eight principal rays. These somewhat thick, but *not exactly cylindrical* rays, which spring from a thickened central node, are often beset with knot-like protrusions. Each bears a bundle of four to eight thin straight terminals of equal length, which diverge slightly from one another, without being sharply marked off from the principals. Each terminal ray bears on its extremity a minute disc (Pl. LVII. figs. 4, 5; *cf.* Pl. LXV. fig. 3). I am of opinion that some of these apparent principals have arisen by the splitting of real or primary principal rays. This is suggested, for instance, by the fact that at their base they are not cylindrical, but somewhat convergent and flattened. From the base of one ray a smooth link may be seen passing to the base of

an adjacent ray. We have, besides, to note the (sometimes very regular) occurrence of a protuberance between the bases of the rays, which is occasionally drawn out into a long radially projecting spine. Or it may be that besides the six principals divided into terminals other independent rays are present, running out into simple points (Pl. LVII. fig. 4).

Finally, the parenchyma includes a tolerable abundance of very minute discohexasters, which are in some regions disposed with especial thickness below the external and under the gastral skin. In these small discohexasters the short simple principals bear broad, plano-convex, transverse terminal discs, from the convex external surface of which numerous delicate divergent terminals arise, which are of equal length, and bear minute transverse discs like those in the rosettes of other sponges as figured in Pl. LVII. fig. 11, Pl. LXI. fig. 7, Pl. LXV. fig. 4.

The greater part of the dermal skeleton consists of autodermal tetracts, in which the rays, intersecting at right angles, and inclined slightly inwards, are cylindrically thickened, or even somewhat club-shaped at their rounded extremities, and are beset throughout their entire length with fine spines (Pl. LVII. fig. 6). In many places, and especially in the hillocky elevations, from which the radial spines project, besides these autodermal tetracts, pentacts also occur in which the four tangential rays are altogether similar to those of the tetracts, while a fifth proximal ray, springing from the node of intersection, projects in a radial direction inwards (Pl. LVII. fig. 7). Between these tetracts and pentacts isolated smooth tetracts occur, double the size of the others, and with their rays intersecting at right angles.

The gastral skeleton consists of small gastral pentacts, which correspond exactly to those of the dermal skeleton. Between these there is a sparse occurrence of tetracts also like the dermal forms (Pl. LVII. fig. 2).

Genus 5. *Bathydorus*, n. gen. (Pls. LVIII., LIX.).

Saccular or bladder-shaped forms, with thin loose walls, smooth or spinous external surface, and thin round oscular margin, which is (always?) provided with a cuff-like fringe of projecting spicules. The parenchyma contains, besides large diacts and hexacts of various kinds, oxyhexasters and in some species discohexasters. The dermal skeleton includes, besides the familiar smooth hypodermal oxypentacts, autodermal oxytetracts, and in some species similar diacts or even monacts. In the gastral skeleton, on the other hand, only roughened oxyhexacts occur.

1. *Bathydorus fimbriatus*, n. sp. (Pl. LVIII.).

In the North Pacific, at Stations 241 and 248, and from considerable depths, the trawl brought up fragments of a somewhat large, bladder-shaped sponge, which was found to be a Hexactinellid of the very simplest structure.

At Station 248, lat. 37° 41′ N., long. 177° 4′ W., from a depth of 2900 fathoms and a red clay ground, the somewhat injured, though coherent upper portion of a bladder-shaped sponge was trawled. The loose smooth wall is only 1 to 1·5 mm. in thickness, and becomes gradually thinner towards the sharp oscular margin, which is surrounded by a fringe of long diact marginalia. The diameter of the bag, which is almost cylindrical in its lower region, measured from 4·5 to 5 cm. The lumen is gradually narrowed towards the upper end, measuring only 2·5 cm. in diameter at the superior terminal opening (Pl. LVIII. fig. 1). The almost uniformly smooth external surface exhibits minute, regularly distributed, round holes, of about $\frac{1}{4}$ mm. in diameter. Somewhat larger round openings may be detected on the internal surface of the gastral membrane, which is also almost uniformly smooth.

An inspection of flattened portions of the wall, or better still, an examination of cross sections at right angles through the wall, reveals distinctly the thimble-like form of the ciliated chambers, which are disposed in a very simple and regularly folded layer between the two reticulate limiting membranes, and supported by the external subdermal and internal subgastral trabecular framework. From the larger, lacunar, subdermal spaces, duct-like diverticula pass between the externally arched folds of the chamber layer. The lumen of each of these cupola-like folds is free from the trabecular scaffolding, and opens into the lacunar subgastral spaces; the latter do not, however, open directly into the general gastral cavity, but only into the loose meshwork of the gastral membrane which stretches smoothly over them (Pl. LVIII. fig. 2).

The larger parenchymalia consist of slender diacts which vary in length, and do not exceed 0·08 mm. in thickness. They are rough and rounded off at their ends, and are frequently somewhat club-shaped in consequence of thickening. A central swelling or formation of tubercles, which take the form of four cruciate, or two opposite elevations, is present in many cases and absent in others. Between these long supporting spicules, which are almost always disposed quite, or approximately parallel to the surface, numerous oxyhexasters occur, with a variable number of long terminal rays, which are either straight or gently curved (Pl. LVIII. figs. 4, 7). This curvature of the long terminal rays frequently assumes an S-shaped form, and results in the formation of minute, delicate, three or four-rayed perianth-like whorls at the end of the principal rays (Pl. LVIII. fig. 7).

The dermal skeleton is supported by medium-sized, smooth, hypodermal oxypentacts, in which the four tangential rays, intersecting at right angles, lie close below the dermal membrane, and are opposed to the corresponding tangentials of adjacent pentacts to

form a quadrate lattice-work. They are usually curved slightly inwards. Opposite the straight proximal radial ray which penetrates almost through the thickness of the body-wall, a small distal protuberance is occasionally developed, though usually absent. These pentacts, especially in the neighbourhood of the oscular margin, sometimes protrude beyond the surface of the sponge, and form with their tangential rays, as in *Rossella*, a sort of veil over the skin; but this differentiation occurs only locally and exceptionally.

The dermal membrane itself includes a large number of small, simple, roughened oxytetracts, in which the arms, intersecting at right angles, seem to be usually somewhat bent inwards (Pl. LVIII. figs. 2, 5).

The gastral skeleton seems wholly destitute of hypogastralia, and consists merely of the very numerous gastral oxyhexacts, in which pointed rays are thickly beset with fine spines. The ray which projects radially inwards into the gastral cavity is usually quite as long as the five others (Pl. LVIII. figs. 2, 6). The marginalia, which project in cuff-like form round the superior oscular margin, are smooth oxydiacts, 8 to 10 mm. in length, without definite central swelling or formation of knots, and with simple pointed ends.

At Station 241 (lat. 35° 41′ N., long. 157° 42′ E.), from a depth of 2300 fathoms and a red clay ground, the trawl brought up some flat fragments, 1 mm. in thickness, which corresponded in their whole appearance to the above described *Bathydorus*. They exhibited the same structure as the above, with the single exception of the parenchymal oxyhexasters, in which the long terminal rays were never so thickly disposed in perianth fashion, as was frequently the case in the above-described form. Here they all diverge more or less, as was indeed occasionally the case above. The spinous gastral hexacts exhibit somewhat longer radial rays than do those in the form already described. I do not think, however, that these slight differences justify the erection of a distinct species, but believe rather that we have here to deal merely with a local variety, and therefore refer these fragments without hesitation to *Bathydorus fimbriatus*.

2. *Bathydorus stellatus*, n. sp. (Pl. LIX. figs. 1–5).

In Messier Channel, off Patagonia, right in front of Port Grappler (Station 307, lat. 49° 24′ 30″ S., long. 74° 23′ 30″ W.), from a depth of 140 fathoms and a blue mud ground, the trawl brought up a small inconspicuous sponge form, about 15 mm. in length. The thin-walled saccular body was divided superiorly into two terminal tubes, 6 mm. in breadth, with terminal apertures. On the otherwise smooth external surface, some thin pointed spicules project obliquely outwards and upwards for 5 to 6 mm. At the terminal oscular aperture no distinct crown of marginalia is to be seen, but this is perhaps the result of slight injury.

The parenchymal spicules are long, narrow, straight or gently curved diacts, with or

without central nodes. The somewhat roughened or tubercled terminal portions are rounded off, or not unfrequently slightly club-shaped at their extremities. Between these a large number of oxyhexasters occur with long, slim, but roughened terminal rays, which vary considerably in number. The principal rays are much shortened, and this goes so far in some hexasters, that the spicule has quite the appearance of a simple, many-rayed star (Pl. LIX. fig. 2). A slight irregularity frequently occurs at the base of these rays, in the occurrence of a slight union or something of that nature, which also points to the reduction above referred to. The presence of these star-shaped parenchymal spicules led me to give this form of *Bathydorus* the specific title *stellatus*. Finally, in the parenchyma, I have observed the isolated occurrence of minute delicate discohexasters, in which each of the six short principal rays bears, on a terminal expansion, three to six long diverging terminal rays with a toothed terminal portion (Pl. LIX. fig. 4).

The dermal skeleton contains medium-sized, smooth, hypodermal oxypentacts, with rough conically pointed ends, and more or less roughened autodermal tetracts, with rounded extremities, disposed flatly in the dermal membrane (Pl. LIX. fig. 3). Between these, pentact forms occur with uniform proximal radial rays, and sometimes diacts also with central nodes (Pl. LIX. fig. 5).

The gastral skeleton, which is not well preserved, consists of rough or spinous oxyhexacts. The pleural prostalia are simple or strongly developed oxydiacts, about 1 cm. in length.

3. *Bathydorus spinosus*, n. sp. (Pl. LIX. figs. 6–9).

Near Penguin Island (Station 147, lat. 46° 16′ S., long. 48° 27′ E.), from a depth of 1600 fathoms and a Diatom ooze ground, the trawl brought up a thin-walled sack, 6 cm. in length and 3 cm. in greatest diameter, but reduced to 2 cm. in width towards the superior, irregularly contoured terminal aperture. The surface of the sack exhibited irregularly scattered pointed spicules, projecting for about 6 mm., while the oscular margin bears a corona of marginalia. It is possible that this sponge form does not represent a distinct species, but belongs to the above described *Bathydorus stellatus*, which it resembles in general structure, and especially in the nature of the siliceous spicules. There is, however, a certain difference about to be noted, which seems to warrant at least a provisional separation of the two forms. I have, therefore, regarded the distinction as really specific.

While the long diacts of the parenchymal skeleton are not in any way essentially different from the long diacts of *Bathydorus stellatus*, I find that the abundant oxyhexasters differ from those of the above species in this, that the principal rays are not usually so markedly shortened, even to disappearance, as they are in the above; the

terminal rays are, further, for the most part somewhat wavy in their curvature (Pl. LIX. figs. 8, 9). I did not discover any small discohexasters.

The dermal and gastral skeletal elements correspond almost perfectly to those of *Bathydorus stellatus*, though it may be noted that the gastral oxyhexacts are here very varied, sometimes rough, sometimes spinous, and rarely quite smooth, as represented in Pl. LIX. fig. 7. In general, in spite of the larger size of the specimen, the rays of its hexact gastralia are less strongly developed than in the much smaller specimens of *Bathydorus stellatus*.

The pleural and marginal prostalia are, like those of *Bathydorus stellatus*, simple smooth oxydiacts, 8 to 10 mm. in length.

4. *Bathydorus baculifer*, n. sp. (Pl. LIX. figs. 10–18).

In the middle of the South Pacific (Station 286, lat. 33° 29′ S., long. 133° 22′ W.), from a depth of 2335 fathoms and a red clay ground, the trawl brought up a small fragment of a sponge which apparently belongs to the genus *Bathydorus*. The specimen, as figured in Pl. LIX. fig. 10, is a tolerably smooth, approximately semicircular plate, 2 mm. in thickness. From the smooth surface some isolated simple oxydiacts project obliquely for 10 to 20 mm., while the other surface appears uniformly rough.

The spicules of the parenchyma are long, narrow, smooth diacts, with rough, conically pointed, rounded, or more rarely slightly club-shaped ends, with or without central nodes, exactly as in the other species of *Bathydorus*. Medium-sized simple hexacts occur here and there. Between these there is a very abundant occurrence of oxyhexasters with short principal rays and long straight terminals (Pl. LIX. figs. 12, 13). A few discohexasters also occur with short principal rays, each of which bears usually three diverging terminals, bent convexly outwards at their base, and carrying on their extremities minute, transverse, four-toothed, somewhat convex discs (Pl. LIX. fig. 18).

The dermal skeleton contains medium-sized hypodermal pentacts, with rough, rounded, or somewhat conical extremities, and small autodermal diacts or monacts, which are rough all over, are rounded off at their ends, and exhibit at the central point a definite swelling of the axial canal, or the trace of undeveloped rays, usually in the form of two opposite, or more rarely four cruciate tubercles (Pl. LIX. figs. 14, 15, 16, 17). The hypodermal pentacts form, by the apposition of their opposite tangentials, a quadrate lattice-work. The autodermal diacts and monacts occur in irregular disposition in the dermal membrane (Pl. LIX. fig. 11). In the diacts the two rays belong as a rule to the same axis, but forms occasionally occur, as figured in Pl. LIX. fig. 16, where the two rays form a right angle. In the monacts, which occur in tolerable abundance, the end which represents the centre of the original six-rayed form, and which therefore contains the node of intersection of the axial canals, exhibits a club-shaped thickening, and it may

be that three, or less frequently five, boss-like projections remain, which correspond in their position to the undeveloped rays (Pl. LIX. fig. 14).

The gastral skeleton is unfortunately not preserved, and this fact may make it somewhat doubtful whether I am correct in regarding this form as a thin-walled *Bathydorus*, and not as a representative of a genus *Rhabdocalyptus*, now to be described.

Genus 6. *Rhabdocalyptus*, n. gen. (Pls. LXIV., LXV.).

The body has the form of a moderately thick-walled cup or sack, with smooth external surface. It is attached by a narrowed base or short stalk to a solid body. The wide round oscular opening has a gradually sharpened smooth margin. The interior surface exhibits, between the close round excurrent apertures of the numerous efferent canal or lacunar passages, an irregular ridged network.

The principal parenchymal spicules are more or less long diacts. Besides disco- and oxyhexasters of various sorts, eight-rayed rosettes occur, with several disc-bearing terminal rays borne on the end of each medium-sized principal.

The dermal membrane contains either only rough diacts, or also rough pentacts, tetracts, and monacts. The gastralia are rough oxyhexacts.

1. *Rhabdocalyptus mollis*, n. sp. (Pl. LXIV.).

Among the dried Japanese Hexactinellids which Dr. Döderlein collected near Enoshima, the form figured in Pl. LXIV. fig. 1 (one-third natural size) is conspicuous because of its large dimensions. It is a moderately thin-walled, laterally compressed cup, 35 cm. in height and 20 cm. in breadth at the superior aperture. The diameter of the round compact stalk is about 6 cm. The large cup bears on its side a smaller, more elongated form, 15 cm. in length, and 6 cm. in width at its orifice; while beneath the latter there is a cæcal protrusion or boss.

The wall, which measures in its lower portion 4 to 6 mm. in thickness, becomes gradually thinner towards the upper end, and terminates in an undulating or crisped, smooth, slender, oscular margin, without a fringe of spicules. At the lower portion of the cup, just above the solid, somewhat tuberculated base, there is a round hole, 5 mm. in diameter, which establishes a communication between the gastral cavity and the water outside. The stalk is attached to the firm substratum by a slight basal expansion, and includes here and there some intruded material, especially soil debris. The lower surface of the stalk, where it is fixed to the substratum, exhibits the familiar thin but firm reticulated plate, which is developed in all Hexactinellids at their point of attachment to foreign bodies. The outer surface of the body is not quite uniformly curved, but exhibits

gentle elevations and depressions, which may be, however, the results of desiccation. The inner surface of the wall of the cup exhibits here and there inconspicuous, ridge-like elevations with a thin edge.

The extremely delicate dermal membrane, which forms a fine lattice-work is preserved only in a few sheltered portions. The parenchymal skeleton is represented by a feltwork of spicules, which are disposed in strands 2 to 4 mm. broad, and enclosing roundish spaces of various sizes. The gastral skin, which also forms an extremely delicate and fine network, exhibits a feltwork of spicular strands with meshes somewhat narrower than those in the dermal skeleton.

The subsequent influence of damp has caused this specimen to fall in, so that the two halves of the wall of the cup have been united. I was therefore unable to discover anything definite as to the nature of the inner surface or of the oscular margin. Dr. Döderlein told me, however, that this specimen, even when still well preserved, "exhibited a marked lateral compression. The inner wall or cup exhibited ridged elevations. The free upper margin had no marked plaiting, and ended in a slender smooth edge without a fringe of spicules. At the base of the cup the larger apertures of the efferent canals were apparent."

A second smaller specimen of this species, measuring 13 cm. in height and 8 in breadth, agrees closely with the above. It also exhibits a laterally compressed cup-like or saccular shape, with a thin oscular margin, but is attached to the firm substratum at several places, over a comparatively broad expansion. Two roundish apertures, 4 mm. in diameter, occur near the lower end.

The principal portion of the parenchymal skeleton consists of long slender diacts, occurring either isolated or disposed in strands. They exhibit a central nodal thickening, and the rough ends are sometimes conically pointed, sometimes simply rounded, and occasionally thickened in a club-shaped fashion. Between these there is a scattered occurrence of the familiar oxyhexasters, in which the principal rays are very short, and frequently almost aborted, while long terminal rays, present in variable number, are somewhat curved at their base, but otherwise quite straight on to the pointed outer end. Oxyhexacts occasionally occur in which the rays are twisted at a point corresponding to that at which the terminal rays arise from the principals in the oxyhexasters. They are doubtless degenerate oxyhexasters, which are again almost reduced to simple oxyhexacts, retaining only a trace of their metamorphosis in the twisting at the base.

In certain regions, especially in the subdermal trabecular spaces, there is an abundant occurrence of large rosettes with terminal rays bearing terminal discs. These spicules but rarely exhibit the typical number of principal rays, but as a rule eight are present. When only six principals are present, as in the form represented in Pl. LXIV. fig. 7, they intersect as usual at right angles in a somewhat thickened node, and are rather thick and cylindrical. At the slightly expanded outer end they divide into three to six straight or somewhat **S**-shaped terminals, which diverge slightly in a tuft, and attain a

length double that of the principals. Each terminal bears at its extremity a small, convex, transverse disc, with recurved marginal teeth (Pl. LXIV. fig. 7). In these discohexasters the central node is occasionally much thickened, and provided in the angle between each two principal rays with radial, tubercle-like rounded processes, which may also be drawn out into simple spines. In other cases, one or two of the principals are especially thick, and split up externally into several terminals; and this modification appears to me to indicate the way in which the numerous rosettes have arisen, which bear eight principal rays arising at approximately equal angles from the central node. The variations in the rays of these rosettes are so numerous that it is impossible to attempt to describe all the modifications. I shall only note that not unfrequently the central node becomes swollen into a conspicuous sphere, from the surface of which, besides several broad principals, numerous terminals also arise, evidently by the basal splitting of the principals. The splitting of a particular portion may thus increase till the whole principal is divided.

Under the skin these peculiar discohexasters occur in abundance, but in other regions, and especially in the subgastral trabecular space, peculiarly modified oxyhexasters, oxyhexacts, and remarkable diacts, derived by reduction from the latter, occur abundantly. In numerous oxyhexasters and oxyhexacts, the curved basal portion of the otherwise quite straight, gradually pointed rays, bears a coating of fine spines or barbs, directed obliquely inwards. These barbs are very numerous, and sometimes so long that those of adjacent rays almost unite (Pl. LXIV. figs. 8, 9). On these spinous oxyhexacts the rays are sometimes curved, and this not unfrequently takes the form of a spiral twisting of the two rays on the same axis (Pl. LXIV. fig. 10). If it happen, as is by no means unfrequent in these spinous spicules, that the number of rays is reduced, forms result like those represented in Pl. LXIV. fig. 11, in which a spherical, spinous, central body bears at its two opposite poles two spinous rays, which are twisted half round in a spiral and then continued in a straight course to end in a simple point, or to be divided into several pointed terminals. But the multiplicity of structure in these apparently reduced forms is so extremely great, that I will not begin to give a detailed account of the multitudinous modifications.

The dermal skeleton is supported by medium-sized hypodermal oxypentacts, in which the long smooth rays sometimes exhibit a simple curvature, but are, as a rule, quite straight. In the dermal membrane itself, numerous autodermal diacts occur, in which the rough rays, lying in one axis, end conically or are somewhat rounded off. The centre usually exhibits two or four projecting tubercles (Pl. LXIV. fig. 5), but these are in other cases entirely absent (Pl. LXIV. fig. 6). There is an isolated occurrence of well-developed tetracts with rays crossed at right angles, and even pentacts with a ray penetrating the parenchyma and resembling that of the diacts. Monacts occur less frequently than in *Bathydorus baculifer*, but still in tolerable abundance. They may

be with, or without lateral tubercles at the expanded end. Finally, I should mention that here and there small discohexasters occur with numerous terminal rays on the expanded ends of the principal rays, like the similar structures in *Rhabdocalyptus roeperi*, represented in Pl. LXV. fig. 4.

The gastral skeleton consists of strong, rough oxyhexacts, similar to those in the genus *Bathydorus*.

2. *Rhabdocalyptus rœperi*, n. sp. (Pl. LXV.).

To the south of Puerta Buono, in Patagonia (Station 310, lat. 51° 27′ 30″ S., long. 74° 3′ W.), from a depth of 400 fathoms and a blue mud ground, the trawl brought up a cup-shaped Hexactinellid, 16 cm. in length and 9·5 cm. in maximum breadth. The solid inferior portion of the sponge is contracted into a cylindrical stalk, 2·5 cm. in thickness. This stalk is bent to the side, as if to be attached to some solid body, but the rest has been unfortunately torn away. The somewhat bulging wall of the cup has a thickness of 8 mm. at the lower part, but decreases gradually towards the upper margin, and ends in a simple smooth margin, bent slightly outwards. The sharp, uniform, circular edge exhibits no projecting marginalia. Through the thin even lattice-work of the dermal membrane are seen the irregularly scattered, elongated, angular or spindle-shaped pits, from which roundish canals extend towards the centre. On the inner surface round sharply contoured depressions of various sizes occur, into the bottom of which the more or less wide excurrent canals of the efferent system open (Pl. LXV. fig. 1).

Besides this large specimen a small, flat, wide cup- or basin-like form was obtained at the same locality. It measured 2 cm. in maximum breadth and 1 cm in height, but was also torn away from its connection, and exhibited only a torn base, 1·5 cm. in breadth. From this the side wall of the body, measuring about 2 mm. in thickness, arises, projecting obliquely upwards and outwards, and continued on to a smooth, circular, sharp-edged margin, measuring 2 cm. in diameter (Pl. LXV. fig. 2). In perpendicular cross sections through the wall of the cup one can readily detect the alternating afferent and efferent canals, and the folds of the chamber layer which extends between them.

The main portion of the parenchymal skeleton consists of long slender diacts with rough pointed or slightly club-shaped ends, with or without central nodes, like those which have been already so often described in this family (Pl. LXV. fig. 11). There is an isolated occurrence of small, weakly-developed oxyhexacts with fine straight rays (Pl. LXV. fig. 6), and a greater abundance of oxyhexasters with short, sometimes very short, principal rays, bearing long, diverging, straight or wavy, fine terminals (Pl. LXV. fig. 5). The number of terminals on each principal ray varies from two to three, while less frequently only one is present.

Not unfrequently the principal rays are so short that they can hardly be detected,

being hidden by a spherical central thickening, from which the long terminals directly arise, resulting in a many-rayed form.

In certain regions, and especially below the external skin, in the subdermal space, there is a tolerably abundant occurrence of those eight-rayed discohexasters, which were already described in *Rhabdocalyptus mollis.* Here also there are eight medium-sized principals not exactly round, but somewhat angular. These form approximately equal angles with the central node, which is beset with roundish tubercles. Terminally the principals divide into three to four fine, long, diverging terminals, which bear on their extremities small, toothed, transverse discs.

We have also to note the quite isolated occurrence of very small delicate discohexasters (Pl. LXV. fig. 4), in which the expanded ends of the principal rays bear numerous fine terminals, with transverse discs on their extremities.

The dermal skeleton includes medium-sized hypodermal oxypentacts, in which the long, smooth, occasionally somewhat curved rays, are roughened towards the pointed extremities. The dermal membrane itself contains a large number of pentacts, tetracts, diacts, and occasionally monacts, in which the rough straight rays, beset with small pointed spines, are rounded off at their outer ends, or provided with blunt points (Pl. LXV. figs. 7, 8, 9). At the middle of the diacts and at one end of the monacts, four or five cruciately disposed hemispherical tubercles (or sometimes two in one axis) project laterally as rudiments of the undeveloped rays (Pl. LXV. figs. 7, 8).

The gastral skeleton, and that of the skin which lines the wide efferent canals, consists exclusively of comparatively large oxyhexasters in the usual disposition. The weakly developed straight rays, which are of approximately equal length, have an irregularly tubercled or roughened surface (Pl. LXV. fig. 10).

There are no marginalia in this species.

Genus 7. *Crateromorpha*, Gray (Pls. LXI.–LXIII., LXVII., LXVIII. fig. 2).

1872. Carter, Ann. and Mag. Nat. Hist., vol. x. p. 110 (*Crateromorpha meyeri*).
1872. Gray, Ann. and Mag. Nat. Hist., vol. x. p. 136.
1873. Carter, Ann. and Mag. Nat. Hist., vol. xi. p. 275.
1873. Carter, Ann. and Mag. Nat. Hist., vol. xi. p. 349.
1874. Gray, Ann. and Mag. Nat. Hist., vol. xiii. p. 284.
1875. Carter, Ann. and Mag. Nat. Hist., vol. xvi. p. 1.
1875. Marshall, Zeitschr. f. wiss. Zool., Bd. xxv., Suppl., p. 142.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii. p. 113.
1877. Zittel, Mitth. d. Baier. Akad., xiii. p. 1.

History.—Among the sponges which Dr. A. B. Meyer sent home from Zebu (one of the Philippine Islands), to the British Museum, there is an oval cup- or bell-like form with a round but comparatively slender stalk. This form was distinguished by Gray as

Crateromorpha meyeri, and was first described by Carter.[1] The approximately round stalk, which was as long and as thick as one's finger, and connected by a trumpet-like expansion with the "cup- or goblet-shaped body," was found by Carter to be perforated by a large number (twelve) of longitudinal canals "which open into the vents of the bottom of the cup where the stem joins the latter." At the lower end the stalk was expanded and adapted for fixing the sponge to the sandy bottom of the sea. The margin at the brim of the cup was extremely thin, but the wall became thicker towards the base. The principal forms of spicules which Carter found in the goblet-shaped body were "(1) straight, fusiform spicules terminally swollen and spinose, also more or less swollen and smooth in the centre, where the central canal has a hexradiate cross, opposite to the ends of which two or four tubercles may occur. These spicules form bundles crossing one another at right angles, or approximately so, and thus support the dermal network. (2) Nail-like or cruciate spicules, in which the arms are smooth, straight and pointed, the shaft a little longer than the rest, also occur somewhat sparsely. (3) Minute smooth hexradiate spicules, in which each arm of the cross, just after leaving the centre, divides into two long divergent spines, are present in myriads. (4) In the pore-bearing area cruciate spicules occur, in which the arms, arising at right angles from the centre, are more or less expanded at the ends and spinose throughout. (5) The stem contains, in addition to the rod-like spicules forming a woolly mass, large, smooth, thick spicules, four-twelfths of an inch in length, accrate and swollen at both ends. These occur distributed longitudinally over the surface of the stem."

Gray[2] repeats Carter's description in somewhat different language, and establishes on the strength of this specimen the family Crateromorphidæ with the following characteristic:—"Sponge cup-shaped, attached by an elongated pedicel formed of numerous short spicules. Body of sponge covered externally with hexradiate spicules, the outer ray of which is aborted, placed in longitudinal and transverse lines, making a square mesh; hollow with large oscules which diminish in size as they reach the margin of the cup. Stem formed of numerous cylindrical tubes situated in a spiculous felt, ending in a bunch of filaments sunk in the mud."

In 1876, Marshall[3] gave the following diagnosis of the genus:—"Polyzoic, with pseudogaster (?) of beaker form, outer side of the beaker-like cup perforated by cylindrical spaces (the stomachic cavities ?), others of the same kind running longitudinally to spaces in the base of the cup. In the internal skeleton the hexradiate forms of spicules disappear, and uniaxial forms occur. Body cavities covered by peculiar small hexradiate spicules with bifurcated rays (?). Dermal skeleton of five-rayed spicules. No proper root-tuft. Rosettes with numerous secondary knobbed rays."

Crateromorpha meyeri is regarded by him as a pollakid Hexactinellid which has

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. x. p. 112.
[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. x. pp. 136–137.
[3] *Zeitschr. f. wiss. Zool.*, Bd. xxvii. p. 126.

degenerated in several points, as may be seen in the preponderance of uniaxial spicules, and also in the absence of a special root-tuft.

Character of the Genus.—The somewhat thick-walled cup- or bowl-shaped body is firmly attached to the substratum by means of a more or less long and compact cylindrical stalk. The sharpened circular oscular margin usually bears a membranous, perpendicular, annular fringe, though occasionally naked. The external surface appears smooth and sometimes meshed. On the internal surface the numerous efferent canals open, through roundish apertures of variable size, directly into the large gastral cavity. The parenchyma includes oxyhexasters and discohexasters of variable form and size. The dermal membrane contains small rough tetracts and pentacts, and sometimes also diacts, which are blunted terminally or thickened in club-shaped fashion. The gastral membrane contains roughened pentacts.

1. *Crateromorpha meyeri*, Gray (Pl. LXI.).

Near Zebu, Philippine Islands (Station 209), from a depth of 95 fathoms and a blue mud ground, several well-preserved specimens of *Crateromorpha meyeri* were obtained.

The sponges are 10 to 12 cm. in height, and of a beautiful wine-glass-like form. An irregular expansion (basal plate) attaches the sponge to the firm substratum, and the cylindrical stalk, about 5 cm. in length and about as thick as one's little finger, is continued through a trumpet-like enlargement into a widely open bulging cup, about 5 cm. in breadth. The wall of this cup is inferiorly about 2 cm. in thickness, but becomes narrower upwards and finally ends in a delicate, thin, transparent, straight or slightly outwardly curved lamellar fringe, with a sharp edge, which measures 4 mm. in height, and about 0·5 mm. in thickness. The external dermal surface of the whole sponge is smooth, but through the fine rectangular lattice-work of the dermal membrane the irregular roundish cavities of the afferent canals may be seen (Pl. LXI. fig. 1). On the much firmer internal surface there are numerous roundish openings of varying width. These belong to the efferent canals. The smaller apertures in the neighbourhood of the lattice-work are still covered by the gastral membrane, but the larger open freely. Inferiorly the openings of the efferent system of canals become larger, so that finally, at the foot of the gastral cavity, only more or less narrow septa remain between them. (Pl. LXI. fig. 2). The larger septa extend radially from the centre towards the lateral wall, and produce a radially symmetrical division into four, which recalls a similar condition in species of *Hyalonema*. In longitudinal sections the relation of the afferent and efferent canals is very distinctly seen, and between them the much folded layer of ciliated chambers (Pl. LXI. figs. 2, 3).

In Pl. LXI. fig. 1 an attempt is made to reproduce the peculiar grey-yellow colour,

exhibited by these forms of *Crateromorpha*, and by the great majority of the spirit-preserved Hexactinellida here described. It is noteworthy that the marginal fringe which surrounds the superior circular opening (about 40 mm. in width) is not yellow, but usually white. The stalk also appears somewhat lighter in colour than the dark grey-yellow body-wall (Pl. LXI. fig. 1).

The main mass of spicules in the parenchyma of *Crateromorpha meyeri* consists, as in *Bathydorus* and *Rhabdocalyptus*, of long thin diacts, which are roughened terminally, and exhibit either rounded off or bluntly pointed extremities. Some spicules bear a distinct central thickening, or four cruciate, or less frequently two opposite hemispherical tubercles, while the others exhibit no trace of such structures. The diacts vary greatly in length and thickness, and are sometimes thickened terminally in a slightly club-shaped fashion. Less frequently they are gradually narrowed and finally terminate in points, while the middle portion is so thickened that the whole spicule acquires a spindle-shaped form. Between these diacts of various length, medium- and small-sized oxyhexacts occur in irregular distribution. In these the rays are frequently of considerable length, and are uniformly narrowed towards the extremity, finally terminating in a point.

There is an abundant occurrence of oxyhexasters with very short, sometimes almost aborted, principal rays, and long slender terminals, which are usually bent slightly outwards at the base, but are otherwise straight up to their pointed extremities. Each short principal bears two to four of these terminals. Less frequently, and chiefly on the subgastral trabecular space, small discohexasters occur, in which the moderately short principal rays are terminally expanded into a transverse disc. The convex surface of this disc bears a brush-like tuft of fine terminal rays, with toothed transverse discs on their extremities (Pl. LXI. fig. 7).

The dermal skeleton includes medium-sized hypodermal oxypentacts, with moderately long and strongly developed straight rays, which are roughened near the extremity, but are elsewhere smooth. The four tangential rays, which are cruciately disposed round a central node, are at first slightly expanded and decrease gradually in thickness towards the pointed ends. Besides these hypodermalia which do not always form a quadrate lattice-work with their tangential rays, a large number of small dermal pentacts occur, with rough straight rays, of approximately equal length, and frequently somewhat club-shaped at their extremities. The four tangentials intersecting at right angles are often inclined slightly inwards. From the point of intersection a knob-like tubercle sometimes projects outwards, representing the undeveloped external radial ray (Pl. LXI. fig. 10); it is, however, generally absent. Between these dermal pentacts, perfectly similar tetracts not unfrequently occur, in which the four rays, intersecting at right angles, are usually curved slightly inwards.

In the gastral skeleton, as in *Rhabdocalyptus*, there are no large hypogastralia. The autogastralia are all small rough pentacts, in which the straight rays are not club-

shaped terminally, but simply rounded, or else with a blunt point (Pl. LXI. fig. 9). The node of intersection is frequently thickened, and usually exhibits a slightly projecting tubercle, representing the undeveloped sixth ray. While this sixth ray is undeveloped in the gastralia proper, it appears distinctly on the spicules which serve to support the lining of the efferent canals, and exactly resembles the other five rays. The canalaria are therefore oxyhexacts, and the sixth ray usually projects for a greater or less distance into the lumen of the efferent canals. While they form a continuous layer on the internal surface of the wider canals, they occur more sparsely in the narrower branches, and may finally be altogether absent (Pl. LXI. fig. 3). There are no special marginalia, since the lamellar oscular fringe described above ends in a simple smooth edge.

The stalk demands special notice. Though its structure essentially resembles that of the cup-shaped body, there are several peculiarities worth noting. It is penetrated by several anastomosing longitudinal canals which open above into the gastral cavity of the cup, and receive laterally the short efferent canals of the wall.

The long diacts of the parenchyma have almost exclusively a longitudinal disposition, and are more or less abundantly and firmly united by transverse synapticula, so that the whole stalk, being penetrated and supported by a continuous and connected framework, is very compact and firm. Only near the external surface, and near the upper end where the stalk joins the cup, are the parenchymal spicules united to a less extent, or not at all. Between the diacts there is a comparatively abundant occurrence of small thick hexacts, which may be isolated, but generally have one or two opposite rays laterally united by a siliceous mass to the long diacts (Pl. LXI. figs. 5, 6).

The degree of amalgamation and connection by means of synapticula increases from above downwards, so that the basal enlargement is traversed by a dense and stony siliceous framework.

The oxyhexasters which occur so abundantly in the parenchyma of the cup-shaped body are less frequent in the stalk, and are only found in those portions where the union of the spicules by amalgamation or by synapticula has not occurred to a very marked extent. I have observed that small discohexasters only occur isolated.

The skeleton of the smooth external skin-layer exhibits medium-sized hypodermal pentacts and small rough dermal pentacts or tetracts, with rounded or slightly club-shaped ray-tips, like those which occurred in the dermal skeleton of the cup-shaped body.

On the inner surface of the large longitudinal efferent canals of the stalk, similar roughened pentacts also occur, with rounded or slightly club-shaped ray-tips. These correspond to the pentact gastralia of the gastral cavity in the superior cup-shaped portion.

This form, which Bowerbank received in 1877 from Dr. A. B. Meyer, and described as an anomalous *Hyalonema*,[1] is not a *Hyalonema*, but certainly *Crateromorpha*

[1] *Proc. Zool. Soc. Lond.*, p. 461, 1877.

meyeri. This was further proved by the examination of a large specimen of the same form, preserved in the Zoological Museum at Dresden, which I was allowed to study through the kindness of Hofrath A. B. Meyer.

I also found a dried specimen of *Crateromorpha meyeri* among the sponges which Dr. Döderlein collected at Enosima in Japan.

2. *Crateromorpha thierfelderi*, n. sp. (Pl. LXII. figs. 1–4).

The stalked cup-shaped form, represented in its natural size in Pl. LXII. fig. 1, was trawled near the Little Ki Island (Station 192), from a depth of 129 to 140 fathoms, and a blue mud bottom. It measures 10 cm. in total length, and 4·5 cm. in maximum breadth. The bulb-like or thick spindle-shaped body is 5 cm. long, and exhibits a simple bulging gastral cavity, about 2·5 cm. in width, opening superiorly by a circular osculum 15 mm. broad, and continued inferiorly into the lumen of the stalk. The stalk is from 6 to 8 mm. in breadth. The lower end of the latter and a large piece of the upper wall of the body have unfortunately been torn away. In its bulging portion the wall is about 8 mm. in thickness, but it decreases rapidly towards the upper end, ending finally in a short, thin, smooth, projecting fringe. Inferiorly, on the other hand, the thickness of the body-wall decreases to about 3 mm. as it joins the stalk.

While the external surface of the sponge appears smooth, the internal surface exhibits numerous round apertures, belonging to the efferent canals. These pores vary in width up to 5 mm.

The parenchyma contains besides strongly developed slightly curved diacts (Pl. LXII. fig. 4) and medium-sized hexacts, also numerous oxyhexasters, with terminal rays bent gently outwards (Pl. LXII. fig. 2). Besides these, there are small comparatively regular discohexasters 0·05 mm. in diameter, with five to eight equal-sized terminals on each principal ray (Pl. LXII. fig. 3).

The dermal membrane contains rough tetracts, and less frequently similar pentacts, with a more or less strongly developed internal ray. In the gastral membrane only roughened pentacts occur.

I have named this form in honour of my friend Professor Albert Thierfelder of Rostock. While it presents a certain resemblance to *Crateromorpha meyeri*, it is also very closely allied to *Crateromorpha murrayi* about to be described, and occupies in fact an intermediate position between these two species.

3. *Crateromorpha murrayi*, n. sp. (Pl. LXIII.).

In the vicinity of the Little Ki Island (Station 192), from a depth of 129 to 140 fathoms and a blue mud ground, the trawl brought up, along with numerous other

Hexactinellids, the beautiful stalked form represented in Pl. LXIII. fig. 1. The cup measured 12 cm. in height, and as much in maximum breadth—at the circular superior opening of the somewhat depressed and yet bell-shaped body. This form I have named *Crateromorpha murrayi* in honour of my much esteemed friend John Murray. The tubular stalk, which is broken off inferiorly, has a parietal thickness of 3 mm., and a diameter of 2·5 cm. Just beyond the trumpet-shaped expansion, where the stalk joins the body, the latter exhibits a rounded boss-like protrusion (1·5 cm. in length), directed outwards and upwards. The external surface of the body and of the stalk is smooth, and covered by a fine quadrate lattice-work, through which numerous roundish incurrent apertures are visible. The internal surface of the wide gastral cavity exhibits numerous round excurrent apertures of the efferent system of canals, which are small in the neighbourhood of the superior margin, but become gradually larger towards the base of the cup, and occur at last so close together, that a network of more or less slender septa protrudes between them into the gastral cavity.

The thickness of the body-wall is on an average between 2 to 3 cm., and decreases gradually upwards to the smooth sharp-edged margin, on which no distinct cuff-like fringe was discoverable.

Of the larger spicules of the parenchymal skeleton the most abundant are those slender diact forms which are beset at both ends with small pointed spines. The ends are thickened in club-shaped fashion, bluntly pointed, or less frequently simply rounded off. In the middle these spicules are in some cases smooth, while in others they exhibit the familiar annular swelling, or else four cruciate or two opposite hemispherical nodes. Beside these we have to note the occurrence—characteristic of the species—of thick diacts of medium length (2·5 to 4 cm.), which are curved in an Indian bow fashion, or else gently twisted in the middle. They are here especially well developed, attaining a thickness of 0·15 mm., and gradually decrease in diameter towards the extremities, where they end in blunt points (Pl. LXIII. fig. 4). The terminal portion may be smooth, as represented in Pl. LXIII. fig. 4, or laterally beset with numerous minute pointed spines.

There is in the parenchyma a remarkably sparse occurrence of large or medium-sized hexacts, an important item in distinguishing this species from the closely related *Crateromorpha thierfelderi.*

Between the large parenchymalia there is an abundant occurrence of oxyhexasters with short principal rays, and two to four long divergent terminals, which have either a perfectly straight course, or are somewhat curved terminally (Pl. LXIII. fig. 5). Less frequently, and especially in the neighbourhood of the gastral surface, another form of rosette is represented by small discohexasters, in which the somewhat short principal rays bear on their terminal transverse discs numerous fine terminals, which vary in length, and bear transversely on their extremities small convex toothed discs (Pl. LXIII. fig. 6).

The dermal skeleton is composed of medium-sized, strongly developed hypodermal pentacts, in which the smooth rays, gradually narrowed towards the extremity, are either simply conical or somewhat roughened and rounded at the tips. Besides these, the dermal membrane includes numerous tetracts and pentacts, and more rarely diacts, with central nodes. These dermalia correspond exactly to those of *Crateromorpha meyeri*. Their straight and rough rays intersect at right angles, and the ends are thickened in somewhat club-shaped fashion.

The gastralia, which form a connected layer lining the gastral cavity, resemble the dermalia, and consist, for the most part, of pentacts with small tubercles or bosses in the place of the sixth ray. Hexacts also occur, in which the projecting radial ray extends for a greater or less distance into the gastral cavity. The canalaria lining the inner surface of the wider efferent canals resemble those just described. The skeleton of the stalk does not essentially differ from that of the bell-shaped body.

4. *Crateromorpha tumida*, n. sp. (Pl. LXVII.; Pl. LXVIII. fig. 2).

Near the Banda Islands (Station 194A, lat. 4° 31′ S., long. 129° 57′ 20″ E.), from a depth of 360 fathoms and a volcanic mud ground, the trawl brought up two specimens of a *Crateromorpha*, in which the very soft body proper has been badly preserved, and so much injured by subsequent friction during transport, that only a cloudy formless mass remains attached to the firm stalk. Fortunately a figure (Pl. LXVII. fig. 1) of one of the specimens had been previously made under Sir Wyville Thomson's direction, which shows at least the form of the body before it was so much damaged. The specimen measures 17 cm. in length. The cylindrical stalk is firmly attached to a compact basal plate, and from its thinnest portion, just above the basal plate (where it measures about 5 mm. in breadth), gradually increases in diameter on to the base of the body, where it attains a breadth of 20 mm. Where the smooth and firm stalk passes into the body, there is a trumpet-shaped expansion with projecting radial ridges and depressions between. The body proper measures 13 cm. in breadth by 8 cm. in height, it exhibits irregular lateral bulgings, and has on the whole the form of a broad cup with very thick walls and with sharp superior margin. The irregular undulating edge of the superior aperture is approximately circular and measures almost 10 cm. in diameter.

The irregularly ridged and furrowed external surface of the body is covered by the delicate lattice-work of the dermal membrane, through which one can see the numerous round lacunæ (1 to 4 mm. wide) of the afferent canal system. The somewhat firmer internal surface of the wide, almost hemispherical gastral cavity, exhibits in its upper marginal region comparatively small apertures of the efferent canal system, which become gradually larger, however, towards the lower surface. It is noteworthy, as a

distinction from *Aulochone*, that from the lower portion of the gastral cavity no canal leads downwards into the stalk, but that the floor of the gastral cavity has the same parenchymatous structure as the lateral wall, and exhibits the same round canalicular apertures as in the latter. The stalk is not a tube with a simple canalicular lumen as in *Aulochone*, but is penetrated by an irregular lacunar and canalicular system, which opens superiorly into the efferent canal system of the lower portion of the body.

The greater part of the parenchymal skeleton consists of long, straight or slightly curved, smooth diacts, with or without central nodes, and with rough club-shaped ends (Pl. LXVII. figs. 2, 3). They occur either in isolated distribution or in strands. Between these a large number of oxyhexasters occur, in which the comparatively short and strong principal rays bear from two to four diverging, long, strongly developed terminals. The extremities of these terminal rays are never bent in hook-like fashion as in *Crateromorpha murrayi* and *Crateromorpha thierfelderi*. Sometimes one or other of the principal rays remains undivided, and not unfrequently both the rays on one axis, so that the latter extends in a simple straight course to a pointed extremity (Pl. LXVII. fig. 5). Between these very numerous oxyhexasters, many-rayed discohexasters occur in very much less abundance, but of about the same size as the former. Each of the short principal rays bears about eight straight, substantial, cylindrical terminals, which are of equal length, and extend, with uniform divergence, radially outwards. On their extremities they bear convex, marginally toothed, transverse discs (Pl. LXVII. fig. 6; Pl. LXVIII. fig. 2).

The hypodermalia of the dermal skeleton are moderately large pentacts, with straight, cylindrical, generally smooth, but terminally roughened and somewhat club-shaped rays. The tangential rays are disposed at right angles to one another and to the proximal radial ray.

The dermal membrane itself contains autodermalia in the form of cruciate tetracts, with rough cylindrical rays, which are usually simply rounded off at their extremities, or less frequently swollen in club-shaped fashion. Diacts also occur, with rays crossed at right angles, and with or without four or two central protuberances. Sometimes, through the abortion of one of the tetract rays, a triact form results (Pl. LXVII. fig. 4).

The gastral and canalicular skeleton is destitute of hypogastralia and hypocanalaria. It consists of rough pentacts, with rays crossed at right angles, and rounded off or somewhat swollen at their extremities.

The spicules of the stalk do not differ from the corresponding forms in the body proper (Pl. LXVIII. fig. 2). In the lowermost portion of the stalk, however, there is, by means of synapticula, a more or less extensive amalgamation and connection of the long diacts, which are longitudinally disposed in approximately or perfectly parallel courses (Pl. LXVII. fig. 8).

The second specimen, which is not figured, has about the same size as the above, and resembled it exactly, though much looser in texture. Not only is the greater part of the body wanting, but the lower end of the conical, expanded, basal portion is quite gone. The region where the stalk passes into the body is somewhat broader than in the former specimen.

Genus 8. *Aulochone*, n. gen. (Pl. LXVI.; Pl. LXVIII. figs. 1, 3–7).

A cylindrical cup is borne on a long tubular stalk. The oscular margin is folded outwards and backwards in such a way that a portion of the gastral surface has become part of the outer wall of the cylindrical body, while the other portion of the gastral wall surrounds the funnel-shaped gastral cavity, and is continued downwards into the membranous lining of the tubular sheath.

In this way the dermal membrane limits the body only on the inferior somewhat hollowed surface, where the cup is attached to the top of the stalk.

This concave, somewhat hollowed, inferior surface of the body exhibits a fine-meshed, quadratic dermal lattice-work, while the cylindrical external surface of the body and the internal funnel-shaped gastral surface exhibit the numerous large and small roundish openings of the efferent water canals.

The parenchyma contains, between the large diacts, numerous discohexasters with terminal rays of variable length. In the dermal and gastral membranes small rough pentacts have a preponderant or exclusive occurrence.

1. *Aulochone cylindrica*, n. sp. (Pl. LXVI.; Pl. LXVIII. fig. 1).

A sponge form, strikingly different in external appearance from the *Crateromorpha* species just discussed, but nevertheless closely allied, as the character of the siliceous spicules plainly shows, was trawled to the north-east of the Kermadec Islands (Station 171, lat. 28° 33′ S., long. 177° 50′ W.), from a depth of 600 fathoms and a hard ground bottom. The sponge consisted, in the first place, of a broken stalk, about 4 mm. in diameter, and 2·5 cm. in present length, but probably much longer when intact. On this the body proper is seated, resembling the vertebral centrum of a bony fish in the infundibular concavity of its terminal surface, and in the cylindrical appearance of the sides (Pl. LXVI. fig. 4). The upper terminal surface is deeply concave in funnel-like fashion, and this funnel-like space is continued directly into the cylindrical tubular cavity formed by the upward prolongation of the stalk. The opposite inferior surface, on the other hand, is hollowed out only to the extent of forming a circular furrow, while the central portion is occupied by the trumpet-shaped connecting portion between stalk and body (Pl. LXVI. figs. 1, 2, 4). Nor is this broad annular furrow on the

lower surface quite uniformly hollowed out, like the funnel-like superior surface, but is somewhat interrupted by four cruciately disposed radial folds which project inwards (Pl. LXVI. figs. 2, 3).

Towards the lower surface with its groove-like concavity, the cylindrical surface of the sides is sharply defined off by a smooth margin with a sharp edge, which projects downwards at a sharp angle. From the upper terminal funnel the cylindrical lateral surface is much more irregularly separated, exhibiting manifold inward folds and less of a sharp margin (Pl. LXVI. figs. 1, 4).

The whole lower surface, from the trumpet-shaped attachment of the stalk to the sharp-edged bounding margin, is covered by a very smoothly expanded dermal network with fine square meshes. Through this, large round lacunæ 10 cm. and more in width can be seen (Pl. LXVI. figs. 2, 3). The character of the cylindrical lateral surface, and of the upper funnel-shaped concavity continued into the central canal of the stalk, differs from that above described in the less uniform development of the bounding membrane, and in its penetration by numerous small and large irregularly disposed round apertures, the latter measuring up to 6 mm. in diameter. These gaps represent the external apertures of numerous efferent canals (Pl. LXVI. figs. 1, 4).

From vertical sections it may be seen that it is only from the inferior grooved surface that the more or less wide afferent canals penetrate upwards into the loose parenchyma of the body, while the corresponding efferent passages all open on the lateral or on the superior funnel-shaped surface (Pl. LXVI. fig. 4). From this it follows that not the superior funnel-like surface alone, but the external lateral cylindrical surface also, corresponds to the gastral surface of other Hexactinellids. The true dermal surface, on the other hand, is represented wholly by the groove-like concavity on the lower surface of the body, and by its direct continuation, the outer surface of the stalk. We have thus to do with an eversion of the originally inner surface of the cup and with a partial overgrowth of the wall, so that a portion of the originally internal gastral surface, that is to say, the upper portion, has become the external lateral surface, while the whole originally lateral external wall has been confined by the outward and downward curvature of the sharp oscular margin to the inferior concave surface of the present sponge body. This theory of the present shape is in complete harmony with the arrangement of the chamber layer and with the distribution of the siliceous spicules. In a vertical section of the downwardly bent, overhanging, sharp edge of the lateral margin, that is to say, of the original everted oscular rim (Pl. LXVIII. fig. 1), it may be seen that the folded chamber layer is disposed in such a way that all the chambers have their convex external surface turned to the delicately latticed skin which covers the grooved inferior surface of the sponge body. The efferent apertures of the chambers, on the other hand, are all directed towards the cylindrical lateral surface, which therefore corresponds to the gastral surface of other sponges, while the inferior surface is really the dermal.

The principal spicules of the parenchymal skeleton are slender, smooth diacts, of varied length. They exhibit rough ends thickened in club-like fashion. Less frequently simply rounded or pointed diacts occur. Many of these long diacts exhibit no swellings or lateral processes at their middle point, while others bear four cruciate, or two opposite tubercles—the rudiments of undeveloped rays.

Between these long parenchymal spicules a large number of irregularly scattered oxyhexasters occur. They exhibit strongly developed, short principal rays, and two to four long, straight, divergent terminals on each principal (Pl. LXVI. fig. 6). It ought to be noted that oxyhexasters very frequently occur in which one principal ray is conspicuously longer than the others, so that the whole spicule deviates considerably from the rosette form. Other irregularities occur, such as the displacement of one of the terminal rays from the common whorl to the side of the associated principal; spinous ramifications or irregular twistings occur here and there as abnormal, or perhaps as pathological modifications (Pl. LXVI. figs. 11, 12). In isolated cases, I observed discohexasters with moderately short principal rays, bearing on their expanded ends numerous long, thin terminals, radially disposed, and each terminating in a transverse disc with clasp-like teeth (Pl. LXVI. fig. 7). In the subdermal spaces of the connecting portion between the stalk and the body, large discohexasters of floricome-like pattern occur, as is also the case in *Aulochone lilium* (Pl. LXVIII. fig. 5). The perianth-like groups of terminal rays are in this species, however, somewhat thinner at their basal and median portions.

The dermal skeleton consists of strongly developed rough pentacts, of variable size, the rays having rounded or club-shaped ends. Between these pentacts, tetracts of similar structure occasionally occur. The gastral skeleton on the upper funnel-like surface, and on the cylindrical sides, consists of rough pentacts similar to the above (Pl. LXVI. fig. 10).

On the much curved regions, both dermalia and gastralia exhibit a backward curvature of the four tangential rays. On the superficial side a small tubercle is occasionally seen where the sixth ray has not been developed.

In the skin which lines the large canalicular cavities of the body, I have never found any special canalaria.

The skeletal elements of the stalk do not essentially differ from those of the body generally. The longitudinal and transverse, *i.e.*, circular, bundles of spicules usually alternate in their arrangement. Between the above, the oxyhexasters and small discohexasters already referred to occur, while the large floricome-like discohexasters are found more abundantly in the subdermal spaces. The dermalia are strongly developed, and the inwardly projecting radial proximal ray is often strikingly shortened. The gastralia are frequently less rough in their median portion, while the club-shaped thickened ends always exhibit numerous minute spines.

2. *Aulochone lilium*, n. sp. (Pl. LXVIII. figs. 3–7).

Near the Meangis Islands, north-east of Celebes (Station 214, lat. 4° 33′ N., long. 127° 6′ E.), from a depth of 500 fathoms and a blue mud ground, the dredge brought up a comparatively well preserved long-stalked type of *Aulochone*, which measured 23 cm. in total length. The rounded pillar-like portion of the body measured 7 cm. in transverse diameter and 4 cm. in height, while the tubular stalk measured 6 mm. in thickness and 19 cm. in height. The stalk forms a funnel-shaped expansion with laterally projecting radial folds before passing into the body proper, and the lumen of this stalk opens into the funnel-shaped gastral cavity within the loose body. The body, which has been somewhat compressed both in capture and preservation, exhibits on its lower side a number of radially projecting folds, which radiate out from four cruciately disposed principal ridges. Between these radial septa there are pouch-like depressions, which are closed externally by means of a sharp-edged margin which projects perpendicularly downwards, and is directly continuous with terminal expansions of the radial folds (Pl. LXVIII. fig. 3). The pouch-like depressions of the lower surface thus appear to be rounded off externally.

The funnel-shaped excavation on the superior surface is bordered by pad-like folds of the body-wall, and is not distinctly limited superiorly or externally. In fact, the gastral wall is directly continued by a rounded superior marginal pad into the somewhat longitudinally folded outer surface of the body. The latter represents, indeed, the everted gastral surface, and is limited towards the inferior dermal surface only at the inferior external sharp-edged margin of the body generally (Pl. LXVIII. fig. 3). It is thus evident that the whole architecture of this sponge agrees with that of *Aulochone cylindrica*, and this is equally true of the internal structure, and especially in regard to the disposition of the folded chamber layer. The convexity of all the chambers within the body is directed towards the cavities, which are pushed in from the lower surface, and enveloped in the dermal membrane; in the stalk, on the other hand, the convexity is towards the external dermal surface. The openings of the chambers within the body are directed towards the external and superior gastral wall, while in the stalk they are turned towards the central lumen of the tube.

The principal spicules of the parenchymal skeleton are long, thin, or slightly thickened diacts, with rough, club-shaped, or simply rounded ends. There is rarely any annular thickening, or development of four cruciate, or two opposite bosses. The rays are for the most part uniformly cylindrical, or slightly thickened in a spindle-like manner, and are perfectly smooth except at their roughened ends. They are either quite straight or gently curved. The abundant parenchymal oxyhexasters correspond exactly in form and size to the oxyhexasters of *Aulochone cylindrica;* they differ, however, markedly in this, that the long terminals are completely covered with small spines, being in fact very *rough*

(Pl. LXVIII. fig. 6). Another divergent rosette form is represented by a floricome-like discohexaster, which occurs in considerable abundance, especially in the subdermal trabecular space and on the transverse terminal expansions. This form exhibits six comparatively short and simple principal rays, each equipped with a whorled tuft of long, fine, S-shaped terminals. These bear on their extremities marginally toothed plates, which overhang towards the exterior. The number of terminals on each principal ray varies. Sometimes there are but six in a single whorl, sometimes eight, ten or more, and they are not always of equal length (Pl. LXVIII. fig. 5).

The parenchymal spicules of the stalk differ from those of the body in this, that the long diacts are stronger, and in part, at least, in the inferior portion of the stalk, directly united by synapticula. Besides oxyhexasters and discohexasters, peculiar hexacts occur with short but thick rays, which meet in the centre in a sort of trumpet-shaped basal expansion, forming a thick node of intersection. The outer rounded extremity is always beset with small spines, which sometimes extend over the entire length. The rays are either of equal length, as in Pl. LXVIII. fig. 7, or to some extent unequal, in that the rays on the same axis are equal to one another, but different from those on the other axes. Less frequently pentacts or tetracts occur of similar form.

The dermal and gastral skeletons are similarly composed of pentacts of variable size, in which the rays are thickly beset with small spines, either throughout as in the dermalia, or over the greater part of their length, that is with the exception of the central portion. At their extremities the rays are either simply rounded off, or thickened in club-shaped fashion. The dermalia have their tangential rays usually inclined somewhat inwards, and exhibit no distal tubercle at the node of intersection. The gastralia, on the other hand, have their tangentials disposed at right angles to the frequently reduced radial ray, and very often exhibit a tubercle or rounded knob, which projects into the gastral cavity, in the position of the sixth ray.

Genus 9. *Caulocalyx*, n. gen.

This genus contains the single species *Caulocalyx tener*.

Caulocalyx tener, n. sp. (Pl. LXIX.).

A fragment of a remarkable sponge form, imperfectly preserved, but indubitably referable to the family Rosellidæ, was trawled in the Mid South Atlantic, to the west of Tristan da Cunha (Station 333, lat. 35° 36′ S., long. 21° 12′ W.), from a depth of 2025 fathoms and a Globigerina ooze ground. It consisted for the most part of a fibrous stalk, frayed out inferiorly, and measuring 4 cm. in length, by 2 to 4 mm. in breadth. Towards the upper end radial lateral folds gradually increase in height, so as to form a cup-shaped

body measuring 4 to 5 cm. in transverse and longitudinal diameter. This loose body was unfortunately very much injured. While the upper funnel-shaped terminal surface, limiting the gastral cavity, is so abundantly penetrated by roundish apertures of variable size that only a network of more or less broad septa and free smooth margins remain, the external, much torn surface is studded with numerous thin and pointed spicules which project freely for 2 to 4 cm. beyond the general surface of the body (Pl. LXIX. fig. 1).

The large spicules of the body-parenchyma consist for the most part of long, rather thin, smooth diacts, which are rough at their ends, and terminate without any marked swelling in a simple conical point. At their centre some exhibit a distinct annular swelling containing an intersection of the axial canal. Most of the spicules, however, remain uniform and cylindrical throughout.

Between these long and slightly bent or looped diacts, a varying number of diverse rosettes occur. The majority are rather large discohexasters, in which the moderately short and simple principal rays usually bear four long divergent terminals. The latter are very thin at their base, but increase gradually in thickness towards the exterior, and finally terminate in a relatively broad, convex, transverse disc, which usually bears a fairly large number of marginal teeth (Pl. LXIX. figs. 3, 4, 7, 8). In the more strongly developed forms, the thickened external ends of the terminal rays exhibit small irregularly scattered tubercles (Pl. LXIX. fig. 7).

Between very weakly developed rosettes of this type, with thin terminal rays (Pl. LXIX. fig. 3), and rather strongly developed forms, twice or three times as broad (Pl. LXIX. fig. 4), many transition types occur.

In addition to the above, we have to note the rather frequent occurrence, especially in the subgastral trabecular spaces, of small plumicomes, in which the moderately short, simple principal rays each bear on their ends a broad convex transverse plate. From the convex external side of the latter, a large number of S-shaped, pointed, terminal rays arise, disposed in perianth-like fashion, and more strongly developed in the outer than in the central portion (Pl. LXIX. fig. 6).

The dermal skeleton is formed of oxypentacts, in which the tangential rays, intersecting at right angles, and often somewhat bent, are laterally beset with scattered, slightly curved spines. The radially directed proximal ray, which is usually much longer, and frequently curved with faint undulations, is, on the other hand, either quite smooth, or merely equipped with minute tubercles (Pl. LXIX. fig. 2). An inconspicuous protuberance may be occasionally observed on the distal side of the node of intersection. The gastralia are somewhat rough oxyhexacts, in which the four tangential rays are straight or slightly curved, and conically pointed at their ends. The moderately long, freely projecting ray is either conically pointed as above, or exhibits a slightly clubbed thickening in front of the terminal point, while the usually longer radial ray opposite

the latter is either conically pointed as above (Pl. LXIX. fig. 5), or becomes gradually narrower towards the end.

In the fibrous rudiment of a stalk, the majority of the long diacts, which vary exceedingly in thickness, have their ends thickened in club-like fashion, or thickly beset with spines, while on the surface of many which are otherwise smooth small spines occur on the middle portion. Towards the lower end of several of the long diacts, which are disposed in longitudinal bundles parallel to one another, one finds spines, bosses, or protuberances of some kind projecting laterally. These seem to represent the rudimentary traces of the synapticula which are subsequently seen in their developed form.

The radially disposed, freely projecting prostalia, which are found on the side and probably were also on the superior margin of the cup-shaped body, are oxydiacts measuring 2 to 4 cm. in length. Their freely projecting surface is, for the most part, somewhat thickly studded with numerous minute, quite irregularly scattered, conical bosses or spines.

Genus 10. *Aulocalyx*, n. gen.

This genus contains only one species, *Aulocalyx irregularis.*

Aulocalyx irregularis, n. sp. (Pl. LX.).

Off Marion Island, south-east of the Cape of Good Hope (Station 145A, lat. 46° 41′ S., long. 38° 10′ E.), from a depth of 310 fathoms and a volcanic sand bottom, several much injured and partially macerated specimens of a Hexactinellid were dredged. The lattice framework still hung together, and the general form was that of a broadly expanded cup with complex, much folded or diverticulated wall (Pl. LX. fig. 1), similar to that observed in *Periphragella elisæ*, Marshall. Although the fragments obtained were only from 3 to 4 cm. in height, it seems probable that the uninjured cup was at least twice as high. Of the soft tissue only some very small fragments remained.

The skeletal framework, which is moderately thick at the base and as hard as stone, becomes gradually looser and more delicate towards the upper end, and finally so sparse and thin, that, as in *Regadrella*, *Dictyocalyx*, *Rhabdocalyptus*, *Hertwigia*, &c., one is inclined to believe that in the upper, most recently added portion no firm fusion of the skeletal elements has occurred.

As to the general structure of the soft tissue, it must be noted that between the two sieve-like, perforated, bounding lamellæ of the body-wall (the dermal and gastral membrane), the membrana reticularis forms in simple folds a connected series of thimble-like diverticula composing the chamber layer. The complication of this folding increases

with the thickness of the wall, and thus differs very greatly in the different regions of the body. The subdermal trabecular framework, extending between the dermal membrane and the chamber layer, exhibits only here and there irregular gaps, while the similar subgastral framework following the concave curvature of the chamber layer exhibits wide lacunæ, which extend into the gastral membrane. A thin layer of the trabecular framework also extends on the inner surface of each concave diverticulum (Pl. LX. fig. 3).

The connected lattice framework of the skeleton consists of medium-sized hexacts, which are united in an irregular fashion either by fusion or by synapticula (Pl. LX. fig. 3).

As can be readily seen in the older portions of the framework, with the help of the much enlarged axial canals, the six rays stand, as a rule, at right angles to one another, but frequently bend from their original direction, and become, as they approach the rays of other hexacts, united with the latter by lateral mooring or by synapticula.

From the complete absence of a regular orientation and mode of connection, it seems to me preferable to refer *Aulocalyx* not to the Dictyonina but to the Lyssacina. In the closer regions of the skeletal framework, between the medium-sized hexacts, numerous small forms occur with short, thick rays, rounded off at the ends, and with a much expanded central portion. These are irregularly scattered, and are united with the former, so that a very close, spongy skeletal meshwork often results.

As to the isolated spicules which occur between the beams of the skeletal framework, either scattered quite irregularly in the parenchyma, or limited to certain regions of the same, I ought first to mention the fine, small, regular oxyhexacts, which occur irregularly, but in considerable abundance, through the whole parenchyma (Pl. LX. fig. 3). They always exhibit a slight roughening of all their rays. Besides these, numerous irregularly distributed, small, regular discohexasters occur, in which, from each of the moderately large, simple, smooth main rays, a tuft of S-shaped thin terminals project in perianth-like arrangement. Each of the terminal rays exhibits a somewhat thickened end, bearing a convex terminal disc with marginal teeth (Pl. LX. figs. 4, 6).

The length of the main rays and the number of terminals on each are the same in one and the same discohexaster, but vary in the different rosettes, of which two very different specimens are figured in Pl. LX. figs. 4, 6.

Another quite unique and characteristic form of rosette occurs, only however in the subdermal trabecular space, but there in comparative abundance. It is distinguished by its conspicuous size and by its peculiar structure, as represented in Pl. LX. figs. 3, 5.

These perfectly regular rosettes have a diameter of 0·4 mm. From each of the relatively short, smooth main rays, six terminals arise, arranged in a whorl, and disposed at equal angles in a funnel-like manner. These long terminals are either straight or somewhat convexly curved at their narrow base, and gradually increase in thickness in club-like fashion toward the simply convex, or more rarely somewhat knobbed external end. They

are beset with numerous, somewhat recurved, thin, pointed barbs, which surround the ray in irregular disposition (Pl. LX. fig. 5).

The dermal skeleton is formed of medium-sized oxypentacts, with comparatively long straight rays, which are, throughout their whole length, somewhat thickly beset with small pointed spines. The very ends of the four tangential rays are blunt and conical, while the proximal ray usually runs more gradually to a point. In the position of the undeveloped (sixth) distal radial ray, a rounded tubercle sometimes occurs. The equally large gastralia exhibit the same structure and similar disposition (Pl. LX. fig. 3).

Several fragments of a connected skeletal framework, belonging to the same species, were also trawled between the Marion and Crozets Islands (Station 147, lat. 46° 16′ S., long. 48° 27′ E.), at a depth of 1600 fathoms, and a Diatom ooze ground. The completely macerated skeleton contained no trace of soft tissue or of isolated spicules.

Genus 11. *Euryplegma*, n. gen.

This genus contains only the one species *Euryplegma auriculare*.

Euryplegma auriculare, n. sp. (Pl. CII.).

Off Raoul or Sunday Islands, to the north-east of New Zealand (Station 170A, lat. 29° 45′ S., long. 178° 11′ W.), from a depth of 630 fathoms, and a volcanic mud ground, two specimens of a plate-shaped Hexactinellid were trawled. They were, however, partly macerated and only fragmentary. The best preserved but broken specimen has the form of a semi-involute ear-shaped plate (Pl. CII. fig. 1). It measures 17 cm. in height, and 6 to 7 cm. in breadth. The macerated skeletal fragment of the other specimen forms a semitubular stalk or basal portion 2 cm. in diameter, and this is continued on into a closed plate 3 to 5 mm. in thickness, which forms the lower portion of a shallow funnel (Pl. CII. fig. 2). The upper portion is unfortunately broken off.

The convex outer surface of the involute ear-shaped specimen (3 to 5 mm. in thickness) seems comparatively smooth, but is penetrated by numerous long oval holes which lead into the runnels and ducts of the afferent canal system (Pl. CII. fig. 1). Near the upper end several of these cavities are covered by a membranous continuation of the thin sieve-like perforated dermal membrane (Pl. CII. fig. 3). The concave internal surface is very rough and uneven in comparison with the outer surface. In the upper portion there is a distinct system of longitudinal ridges with interjacent furrows about 2 mm. in breadth. Somewhat further down they are covered by transverse, arc-like, broad flat zones, so that transverse ridges 4 to 5 mm. in breadth cross at right angles over the deeper longitudinal ridges, and project into the interior. Still further down transverse arcs exhibit knots or cushion-like elevations about 3 mm. in diameter, and

between these there are pit-like depressions of irregular form (Pl. CII. fig. 1). The summit of each of these projecting knots generally bears the aperture (0·5 to 1 mm. in breadth) of an efferent canal. Similar apertures occur in varying abundance between the nodes. The firm basal portion of the specimen is quite destitute of soft parts for a distance of 2 to 3 cm., and must have been quite dead for some time (Pl. CII. fig. 1).

These projecting ridges above referred to are readily brought into relation with the macerated skeletal structure exhibited by the lower portion of the other specimen (Pl. CII. fig. 2). This fragment shows very distinctly that on the outer convex surface there is a reticulate framework, enclosing long, oval or angular meshes, and composed of beams which lie parallel to the smooth arched surface. Internally there lies a system of approximately parallel, or rather somewhat fan-shaped divergent longitudinal ridges which measure 1 to 2 mm. in breadth, and now and again divide. Between these there are longitudinally disposed canals of equal breadth, which are covered internally by a layer of beams for the most part transverse. From this latter layer numerous round perforate swellings and internally open tubes project into the interior.

The round excurrent apertures of the efferent canal system, which measure about 2 to 3 mm. in width, are disposed in longitudinal and transverse rows intersecting at right angles (Pl. CII. fig. 1).

From the macerated skeleton, or better still, from longitudinal and transverse sections of the whole body, it is clear that the latter consists of a much folded plate 2 to 2·5 mm. in thickness, in which the bounding surfaces are formed by the sieve-like dermal and gastral membrane, while between these the much folded chamber layer is supported by means of the familiar trabecular framework (Pl. CII. fig. 3). Many of the entrance apertures of the afferent canals are closed by a second external membrane split off from the dermal. In its peripheral portion this membrane is supported by the subdermal trabecular framework, but is subsequently quite freely expanded (Pl. CII. fig. 3).

The dictyonal framework, which penetrates throughout the entire sponge body, consists of moderately large simple hexacts which are soldered together, or occasionally connected by synapticula in an irregular fashion.

Only in a few regions, and especially in the neighbourhood of the dermal surface, have the dictyonal hexacts the typical form with straight rays disposed at right angles to one another, on which account I had formerly referred this genus to the Dictyonina.[1] But they are usually curved and elongated in very various ways (Pl. CII. fig. 3), so that an intersection and fusion of the rays of adjacent hexacts may occur at very various angles, and the dictyonal framework in fact resembles rather the skeletal framework of several Lyssacina than the ordinary type of Dictyonina. The whole skeletal beam is uniformly thick and cylindrical, with numerous irregularly scattered, minute pointed spines (Pl. CII. fig. 3).

[1] Über den Bau und das System der Hexactinelliden, *Abhandl. d. k. Preuss. Akad. Berlin*, 1886, p. 80.

The parenchymalia lying between the beams of the dictyonal framework consist of small, simple, and regular oxyhexacts, with delicate, straight, and rough rays, which run out with a slightly conical terminal pointing, and of discohexasters which are much smaller than the oxyhexacts, but vary considerably in size and form. Some of them bear on the short simple principals, three to five, rarely more, S-shaped, whorled, somewhat markedly divergent, moderately thin, terminal rays with convex marginally toothed transverse discs (Pl. CII. fig. 5). In other, usually somewhat larger discohexasters of a similar type, the short simple principal rays bear six to ten long terminals, which are similarly S-shaped and disposed in perianth-like fashion, only more closely packed together and with less broad terminal discs (Pl. CII. fig. 4) than in the preceding form. Both forms are connected, however, by numerous intermediate types.

The dermalia are oxypentacts in which the straight or slightly incurved tangential rays are about 0·2 mm. in length, while the straight radial proximal is twice or three times as long. All the five rays are cylindrical, and are smooth except on the conically pointed terminal portion. A distal tubercle sometimes appears as the rudiment of the undeveloped sixth ray. The gastralia have quite the same form and an approximately equal size. They are largest on the gastral surface of the body, and become smaller and more weakly developed the nearer they are to the blind ends of the efferent canal system.

Tribe II. AMPHIDISCOPHORA, F. E. Schulze (Pls. XXVII.–LII.).

The bounding surface-membranes always contain amphidiscs. Hexasters are wholly absent from the parenchyma. There is always a tuft of basal fibres, by means of which the cup- or club-shaped sponge body is rooted in the mud. The ciliated chambers are not exactly thimble-shaped or sharply defined from one another, but appear rather as somewhat irregular diverticula of the membrana reticularis.

Family HYALONEMATIDÆ, Gray (Pls. XXVII.–LII.).

Both dermal and gastral membranes bear numerous pentact pinuli.

Subfamily 1. HYALONEMATINÆ, F. E. Schulze (Pls. XXVII.–L.).

The usually cup-shaped body exhibits a more or less sharp-contoured, circular oscular region, and is only exceptionally split in an ear-shaped fashion.

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1874. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. xii. p. 284.
1874. E. P. Wright, Proc. Roy. Irish Acad., vol. i. p. 549.
1874. Hudlow, Trans. Asiatic Soc. Japan, vol. i.
1875. Higgin, Ann. and Mag. Nat. Hist., ser. 4, vol. xv. p. 377 (*Hyalonema cebuense*).
1875. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xvi. p. 1.
1875. Küstermann, Archiv f. mikrosk. Anat., Bd. xi. p. 282.
1875. Bowerbank, Proc. Zool. Soc. Lond., p. 607.
1875. Marshall, Zeitschr. f. wiss. Zool., Suppl.-Bd. xxv. p. 142 (*Hyalonema thomsonis* and *Hyalonema affine*).
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii. p. 113.
1876. Willemoes Suhm, Zeitschr. f. wiss. Zool., Bd. xxvii. p. xcvii.
1877. Wyville Thomson, The Atlantic, p. 273 (*Hyalonema toxeres*).
1877. Sollas, Ann. and Mag. Nat. Hist., ser. 4, vol. xx. p. 285.
1877. Bowerbank, Proc. Zool. Soc. Lond., p. 461 (*Hyalonema anomalum*).
1877. Young, Ann. and Mag. Nat. Hist., ser. 4, vol. xx. p. 425 (*Hyalonema smithii*).
1878. Carter, Ann. and Mag. Nat. Hist., ser. 5, vol. ii. p. 157.
1878. Maggs, Second Annual Report Devonsh. and Cornwall Nat. Hist. Soc., p. 21.
1879. Agassiz, Bull. Mus. Comp. Zoöl., vol. v. p. 289.
1880. O. Schmidt, Die Spongien des Meerbusens von Mexico, Heft ii.
1880. Norman, Ann. and Mag. Nat. Hist., ser. 5, vol. vi. p. 436.
1881. Milne-Edwards, Comptes rendus, t. xciii. pp. 876, 931.
1885. Armauer Hansen, Spongiadæ of the Norwegian North Atlantic Expedition (*Hyalonema arcticum*).
1886. Filhol, La vie au fond des mers, p. 278.

History.—The first important scientific account of a *Hyalonema* is given by Gray[1] (*loc. cit.*, p. 79). After his description of the Pennatulidæ, the following remarks are found :—" Here also is placed the extraordinary glass-rope (*Hyalonema*, Gray), the axis of which is formed of numerous transparent siliceous fibres, slightly twisted together so as to look like a rope of spun glass ; the fibres appear to be somewhat similar to the calcareous spicula of the Alcyonia. These corals are found with their tapering base inserted in a sponge on the coast of Japan. No animal hitherto discovered, except the inhabitant of this extraordinary substance, secretes pure silex."

Gray gave a more accurate description of this sponge in 1835,[2] regarding it as a *Gorgonia*-like coral with the following generic diagnosis :—" *Hyalonema.* Corallium simplex, subcylindricum, ad basin cortice coriaceo tuberculato tectum ; tuberculis sparsis, depressis, polypiferis. Axis e spiculis numerosis, elongatis, filiformibus, subcontortis, siliceis constans. Polypus ignotus. *Hyalonema sieboldii.* Hab. apud Japoniam. Dr. Siebold."

Against the view held by Gray that the siliceous threads are to be regarded as

[1] Synopsis of the Contents of the British Museum, ed. 27, 1832, London, 12 mo.
[2] *Proc. Zool. Soc. Lond.*, pt. iii. pp. 63–65.

the skeleton of the adherent polype, Valenciennes expressed the belief that we have here to deal with spongoid spicules, and that the polypes occurring upon these belong to the group of the Zoantharia, and are to be looked upon as parasites.[1]

Gray[2] at once defended his views, and pointed out that it was improbable that the polypes should always be found associated with the sponge, or that the association should be so intimate as it was, and noted further that the axis skeleton of the well-known *Gorgoniæ* presents a concentric lamination similar to each of the long siliceous threads.

In a further communication by Gray on the same subject,[3] the family of the "Hyalonemidæ" is regarded as a family of corals, with the single genus *Hyalonema*, with characters which agree, essentially, though not verbally, with the above diagnosis of the genus given in 1835.

Gray reported the presence of ring-shaped or spiral projections on the outer surface of the concentrically laminated long spicules, and communicated the result of the chemical analysis of these by W. Prout and T. J. Pearsall, both of whom gave their composition as hydrated silicic acid.

It is curious that Gray here designates as *Hyalonema mirabilis* the only known species, which he had described in his first communications as *Hyalonema sieboldii*, and that he quotes the Synopsis of the British Museum, 1830, p. 118, as relevant literature. This quotation, which has passed into several later papers by other observers, is proved to be false, inasmuch as in the library of the British Museum no edition of the Synopsis of the year 1830 is to befound, while the edition immediately preceding, published in 1827, contains no communication on *Hyalonema*, either at the page cited or anywhere else. Since I was unable, for want of time, to continue the search further during my stay in London, I requested Mr. Stuart O. Ridley to do so, and the result of his accurate examination—for which I here express my best thanks—has shown that in none of the earlier editions of the Synopsis of the British Museum, down to edition xxvii. of the year 1832—in which the words already quoted are to be found on page 79—does any communication on *Hyalonema* occur. This notice, however, is repeated in the following editions—xxvii. to xl.—without essential change, and further observations are first added in edition xli. of the year 1840. No alternative is therefore left but to believe that Gray made a false quotation from memory, or had perhaps in error taken the note on his museum label or such like for the scientific name which he himself had adopted. This is important, inasmuch as it is not the specific name *Hyalonema mirabilis* used by Gray in the year 1857, but that already given by Gray himself to the same species in 1835, *Hyalonema sieboldii*, which has the priority.

[1] Milne-Edwards and Jules Haime, Monograph of the British Fossil Corals, p. 81.

[2] *Ann. and Mag. Nat. Hist.*, ser. 2, vol. vi. p. 306.

[3] *Proc. Zool. Soc. Lond.*, 1857, pt. xxv. p. 278.

On the systematic position of *Hyalonema*, Gray in 1859[1] asserted that within the group of polypes with feathered tentacles or Alcyonaria, and close to the "Sabulicolæ" which are rooted in the sand, and to the "Rupicolæ" or Gorgonidæ attached to the rock, a third division might be formed, which on account of its rooting on sponges might be named "Spongicolæ," with the single genus *Hyalonema*.

The opinion of Gray as to the polype nature of the remarkable glassy and filamentous tuft, and which became fixed to a sponge, was shared by Brandt,[2] who in 1859 also described the glassy spicular bundle as the axial skeleton of the cortical layer of the polype. Brandt thought that two different genera of polypes could be distinguished, viz., *Hyalonema* with plain discoid polypes, and *Hyalochæte* with cylindrical terminally funnel-shaped solitary polypes, both of which he united in the single family Hyalochætides. In the genus *Hyalonema* he described two species, namely, *Hyalonema sieboldii*, Gray, and *Hyalonema affine*, Brandt; of the genus *Hyalochæta* only the single species, *Hyalochæta possieti*.

The loose fleecy mass in which the conical extremity of the glassy filamentous tuft is usually embedded was referred to by Brandt as a "parasitic sponge" which had destroyed the soft parts of the polype stock at its point of attachment, he also distinguished, though he did not accurately describe, two species of this sponge as "*Spongia spinicrux*" and "*Spongia octancyra*." The attachment of a group of *Hyalonema* to a *Pholas*-bored stone by means of their conical projecting tufted extremity, which occurred in the case of a specimen from Japan, Brandt regarded as artificial.

Of this work by Brandt a critical review by Gray[3] appeared in 1860. Gray asserted that the two genera distinguished by Brandt with their three species were varieties of one and the same species. Ehrenberg[4] also expressed an opinion during the same year as to the nature of this remarkable organism; he regarded the whole as a Japanese artifice, compounded of long sponge spicules and a polype.

A thorough investigation of several dried *Hyalonemata* from Japan was first undertaken by Max Schultze. As a result of this he briefly expressed his views in regard to the relation of the polype and sponge,[5] to the effect that the siliceous filiform cords and the sponge body form an inseparable whole, and that accordingly the *Hyalonema* are to be regarded not as polypes but as *sponges*. In the same year he published the results of his accurate analysis of the formation and structure of the sponge, as well as of the adherent polype crust, in a special monograph, illustrated by beautiful plates, entitled Die Hyalonemen. The opinion expressed in the preliminary communication, that the crust surrounding the spicular tuft also belonged to the sponge body, he soon retracted. He believed that the large cylindrical sponge body became attached by means

[1] *Ann. and Mag. Nat. Hist.*, ser. 3, vol. iv. p. 439.
[2] Symbolæ ad polypos hyalochætides spectantes.
[3] *Ann. and Mag. Nat. Hist.*, ser. 3, vol. v. p. 229.
[4] *Monatsber. d. k. preuss. Akad. d. Wiss. Berlin*, p. 173.
[5] *Comptes rendus*, April 23, 1860, vol. l. p. 792.

of its broad truncated basal plate to a solid substratum, and that the long spicular tuft, whose inferior compact portion is surrounded by the crust of a parasiticp olype, *Palythoa fatua*, projected from the narrowed extremity. Passing over his accurate description of the long siliceous filaments, as well as of the elegant, very manifold, small, siliceous spicules of the sponge body proper, we need only here refer to the important observation made by Max Schultze, to the effect that both in the long tuft-spicules, and in the many-rayed or rod-shaped spicules of the body itself, and even in the axial part of the remarkable "Amphidiscs," a fine central canal extends, which is usually intersected at the middle by one or two transverse canals which cross it at right angles.

While Ehrenberg,[1] in opposition to this opinion of Max Schultze, still maintained that we had to deal with an artificial Japanese production, von Martens examined the debated organism in Japan, and in the same publication (p. 480) essentially confirmed Max Schultze's opinion.

A theory of the nature of *Hyalonema*, similar to that expressed by Max Schultze in his first communication in the Comptes rendus, was expressed some years later by Bowerbank in one of his papers on the Anatomy and Physiology of Sponges.[2] Bowerbank united *Hyalonema* with *Halichondria*, *Isodictya* and *Spongilla*, in the suborder of his Silicea, with a "spiculo-reticulate skeleton,"—the skeleton being "continuously reticulate in structure but not fibrous." The genus *Hyalonema*, Gray, was here characterised by Bowerbank in the following manner:—"Skeleton an indefinite network of siliceous spicula, composed of separated elongated fasciculi reposing on continuous membranes, having the middle of the sponge perforated vertically by an extended spiral fasciculus of single, elongated, and very large spicula, forming the axial skeleton of a columnar cloacal system."

Süss in 1862[3] called attention to a fossil from the Carboniferous limestone of Yorkshire, which had been already described by M'Coy as *Serpula parallela*, which exhibited a bundle of from fifteen to thirty or more round, smooth, parallel rods of the thickness of a knitting needle, and each provided with a central canal. This he named *Hyalonema parallelum*.

In 1864 Barboza du Bocage made a communication[4] on a new species of the genus *Hyalonema*, which was discovered off the coast of Portugal at great depths. He named it *Hyalonema lusitanicum*. Bocage regarded the form and peculiarly regular arrangement of the polypes, which partly surrounded the siliceous spicular tuft and were provided with forty tentacles, as especially characteristic of his new species. His diagnosis runs thus:—"Hyalonema polypario elongato fibris setaceis, hyalinis, spiraliter tortis, corio polypigero ab apice usque ad $\frac{2}{5}$ longitudinis totæ involutis polypis dilatatis, ellipticis valde aggregatis, parum elevatis, per series longitudinales ac spirales regulariter digestis."

[1] *Monatsber. d. k. preuss. Akad. d. Wiss. Berlin*, 1861, p. 450.
[2] *Phil. Trans.*, 1862, p. 1113.
[3] *Verhandl. d. k. k. zool.-bot. Gesellsch. Wien*, 1862, p. 85.
[4] *Proc. Zool. Soc. Lond.*, 1864, p. 266.

On the sponge body Bocage made no observations; he simply notes that the covering of polypes extends without interruption to the pointed extremity of the fibrous cord, where they become somewhat diminished in size. At a later period he[1] supplied some further data as to the locality of his *Hyalonema lusitanicum*—near the mouth of the Tagus—and also confirmed his previous report from the examination of some new material.

The account given by Barboza du Bocage seemed to Gray to be well calculated to support the opinion which he still firmly maintained, that the long fibrous bundle was the skeletal axis of the polype covering. He utilised it in a renewed defence of his views,[2] admitting, however, that he had been so far mistaken in his examination of the individual polypes, since these possessed not eight feathered, but twenty simple tentacles.

Soon after this Bowerbank elaborated[3] his theory in regard to the nature of *Hyalonema*. He now maintained that not only the long tuft of glass-spicules and the cylindrical or conical basal mass, but also the uneven irregular rind surrounding the fibrous tuft, were all parts of the sponge.

A memoir by Max Schultze[4] is noteworthy as containing the proposal to unite the two genera *Euplectella*, Owen, and *Hyalonema*, Gray, into a special group of siliceous sponges with the title "Lophospongiæ."

An accurate description of the sponge named by him *Hyalonema mirabile* was now given by Bowerbank.[5] The cylindrical elevations on the rind of the siliceous tuft, which had been described by most observers as polypes, were recognised as the oscula of the sponge. The form described by Barboza du Bocage Bowerbank[6] looked upon as not specifically distinct from his *Hyalonema mirabile.*

In his comprehensive sponge system published in 1867,[7] Gray designated the large cylindrical body, which he regarded as the whole sponge, in which the long siliceous filaments were embedded, by a new generic name "*Carteria*," assigned to this genus a place in his family of the "Esperiadæ," in the order of the Acanthospongia, and gave to it the following diagnosis:—"Sponge massive, irregularly reticulated, shallow, formed of abundant agglutinated filiform needle-like spicules, with four- and six-rayed stellate, cruciform and birotulate spicules." As the only known genus he mentioned *Carteria japonica* (=*Hyalonema mirabile*, Bowerbank, *Spongia octancyra*, Brandt, and *Spongia spinicrux,* Brandt).

In two communications published in 1867,[8] Ehrenberg maintained his opinion that the entire body was artificially compounded by the Japanese, but communicated in the second paper a letter from Barboza du Bocage, in which the latter declared

[1] *Proc. Zool. Soc. Lond.*, p. 662, 1865.
[2] *Ann. and Mag. Nat. Hist.*, ser. 3, vol. xviii. p. 287, 1866.
[3] *Ann. and Mag. Nat. Hist.*, ser. 3, vol. xviii. p. 397.
[4] *Archiv f. mikrosk. Anat.*, 1867, p. 206; *Ann. and Mag. Nat. Hist.*, ser. 3, vol. xix. p. 153.
[5] *Proc. Zool. Soc. Lond.*, p. 18, 1867.
[6] *Proc. Zool. Soc. Lond.*, p. 902, 1867.
[7] *Proc. Zool. Soc. Lond.*, p. 492.
[8] *Monatsber. d. k. preuss. Akad. d. Wiss. Berlin*, pp. 298, 843.

that he had been convinced of the correctness of Max Schultze's opinion by finding two large specimens of *Hyalonema* with sponge bodies but without the polype crust.

The sponges which Semper described in 1867[1] and in 1868,[2] under the designation of *Hyalonema schultzei*, I shall discuss when considering the genus *Semperella*.

In 1868 Gray made several communications on *Hyalonema*;[3] in the first of these he added to his *Carteria japonica* a second species, *Carteria lusitanica* (= *Hyalonema lusitanicum*, Bocage). In the second he combated Max Schultze's conception of *Hyalonema*, and in the third he expressed the opinion that the sponge described a short time previously by Lovén as *Hyalonema boreale*[4] in no way belonged to the genus *Hyalonema*, Gray (or *Carteria*, Gray), but was from the form of its simple spindle-shaped spicules to be referred to the Halichondridæ, in close relation to *Halichondria ficus*, Johnston (*Ficulina*, Gray). In his later memoir published in English,[5] Lovén described a North Sea sponge, with a club-shaped body and a slender stalk fixed in the sand by means of root-like processes, and bearing a certain external resemblance to *Hyalonema sieboldii*. Lovén conjectured that the Japanese and Portugese *Hyalonemata* were, like his *Hyalonema boreale*, rooted in mud by means of their long tuft-like spreading spicules, and that accordingly the broad cylindrical sponge body of these forms did not represent the base, but was fixed as an upward projecting mass upon the root-tuft.

In the meantime Barboza du Bocage had also discovered, off the coast of Portugal, some sponges which resembled the *Hyalonema boreale*. In his report on these forms,[6] which he had been at first inclined to regard as young specimens of *Hyalonema lusitanicum*, he expresses his conviction that these, along with the *Hyalonema boreale* of Lovén, should be placed in a special new genus "*Lovenia*."

Gray now announced[7] that the Japanese collectors, who sometimes found the diverging extremity of the glassy spicular tuft covered with mud, affirmed that this free tufted extremity was embedded in the mud or sand of the sea-bottom. He was himself inclined to regard this view as correct, and figures[8] a *Hyalonema* placed in this position. It is noteworthy that Gray now returned to the name *Hyalonema sieboldii*, which he first applied in 1835 to the supposed polypes, and thus abandoned the designation *Hyalonema mirabile*, which had been used for a longer period. For the *Hyalonema lusitanicum* described by Barboza du Bocage, he adheres to a generic name which had already been used in 1867, viz., *Hyalothrix*, and he names the specimen in question *Hyalothrix lusitanica*. Both in the case of *Hyalonema sieboldii* and of *Hyalothrix lusitanica*, he admits varieties with and without the adhering sponges.

[1] *Archiv f. Naturgesch.*, Bd. xxxix. p. 84.
[2] *Verhandl. d. phys.-med. Gesellsch. Würzburg*, 1868.
[3] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. i. p. 161, &c.
[4] *Öfversigt k. Vetensk.-Akad. Förhandl.*, 1868, p. 105.
[5] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ii. p. 81, 1868.
[6] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ii. p. 36, 1868.
[7] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ii. p. 271, 1868.
[8] *Loc. cit.*, p. 275.

Percival Wright,[1] who dredged *Hyalonema lusitanicum* from a depth of 480 fathoms south-west of Setubal, and had observed it in the fresh condition, found it embedded in mud up to that part of the siliceous spicular tuft which was not covered by *Palythoa*, while the upper extremity of the tuft bore a sponge body with several oscular openings. In the polypes forming the crust of the stalk movements of the tentacles were observed.

Hyalonemas were dredged in a similar situation in the Gulf Stream by Wyville Thomson from a depth of 550 fathoms.

In his memoir on *Holtenia carpenteri*,[2] Wyville Thomson refers to a *Hyalonema loveni* as a new species, without however describing or characterising it.

Percival Wright[3] now described in an elaborate paper the *Hyalonema* found off the coast of Portugal by Barboza du Bocage, Wyville Thomson and himself, and named it *Hyalonema mirabile*. On a specimen with an oval cup-shaped body, about 8 inches in length and 4 inches in breadth, "a number of irregular large openings (oscula)" could be seen in an upper pitting, and these "are covered over with a delicate open sarcode network, the edges of the meshes of which are thickly lined by the spicules called 'spiculate cruciform spicules' by Bowerbank." A figure of this, given on his pl. iii., shows the sieve-net on the upper truncated surface of the sponge body, extending evenly over the oscular opening and over the layer of the "spiculate cruciform spicules" in the net beams.

The two sponges described by Sars in 1872, in his work "On some remarkable forms of animal life from the great deeps off the Norwegian coast," and named as *Hyalonema longissimum* and *Hyalonema parvum*, manifestly do not belong to the Hexactinellida any more than his *Hyalonema boreale*.

In the work entitled Depths of the Sea, Wyville Thomson reported in 1873 on some *Hyalonemata* which he had dredged to the north of the Butt of Lewis from a depth of 450 to 500 fathoms. In these the root-tuft alone measured 40 cm. or more. He identified these forms as *Hyalonema lusitanicum*, Barboza du Bocage, and figured (*loc. cit.*, p. 421) a slender specimen about 34 cm. in length. It is noteworthy that this figure does not include the sieve-net which was observed by Percival Wright in his Portuguese specimen (described under the title *Hyalonema mirabile*), covering the oscular openings of the upper truncated surface. Instead of this a central conical boss projects about 2 cm. above the upper bounding surface, which is provided with large openings.

Higgin next described, in 1875,[4] a *Hyalonema* from Zebu (one of the Philippine Islands) as *Hyalonema cebuense*. This form resembles, indeed, in many respects the Japanese *Hyalonema sieboldii*, but according to Higgin's description and figures differs from that species chiefly in the following points:—the form of the body resembles that of a hewer's mallet; the polype crust of the stalk is absent; the "large stout acerate

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ii. p. 323.
[2] *Phil. Trans.*, p. 701, 1869.
[3] *Quart. Journ. Micr. Sci.*, p. 73, 1870.
[4] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xv. p. 377.

spicules" occur not only in the interior of the body but also in the superficial dermal layer; the rays of the small hexradiate spicules in the interior are *not bent* but *straight*, and are, up to the pointed extremity, beset with lateral prongs.[1]

Higgin succeeded in discovering in his *Hyalonema cebuense* the true position of the dermal spicules, and Küstermann[2] observed in the same year, in *Hyalonema sieboldii*, the presence of four cruciately disposed anchor-teeth on the extremity of the long tuft spicules. Küstermann also observed, close to the extremity of a tuft-spicule, that the fine axial canal was crossed by two short transverse canaliculi disposed at right angles to one another.

An elaborate description of the minute structural relations of *Hyalonema sieboldii* has been given by Marshall[3] in his admirable Researches on the Hexactinellidæ. He calls attention to the peculiar sieve-like perforated plate which covers the upper truncated extremity of the sponge-body. In the large hollow cavity of this species he also succeeded in discovering round embryos of the size of a millet grain or a pea, and exhibiting a central cavity with a small round excurrent opening. The wall consisted for the most part of smooth hexradiate spicules. On the outer surface spindle-shaped spicules occurred; and long pointed rod-like forms penetrated the wall here and there in a radial direction, and projected for a considerable distance beyond the surface. One of the specimens of the Leyden collection, described by Max Schultze, appeared to Marshall, on account of its different dimensions, and especially on account of the peculiar condition of the dermal skeleton, which was said to exhibit anastomosing bands of long elastic uniaxial spicules with large cross spicules at the anastomoses, to justify the institution of a new species, which he named *Hyalonema affine*. Important deviations from the *Hyalonema sieboldii* type were exhibited by a small (only 7 cm. in length) *Hyalonema* which Wyville Thomson collected to the north of the Shetland Islands, from a depth of 550 fathoms, and which has been named *Hyalonema thomsoni*. Instead of the sieve-net, which extends across the upper truncated extremity of *Hyalonema sieboldii*, a central slender cone, 1 cm. in length, projects freely, and from its expanded base four cruciately disposed narrow ridges extend, forming the upper border of four septa which traverse the cavity of the sponge in a radial direction. Another peculiarity of the *Hyalonema thomsoni* consists, according to Marshall, in the thumb-like prongs which are spirally disposed on many of the tuft-spicules, and which at their union with the ridge-like projecting basal portion of the spicule exhibit a canaliculated appearance.

Wyville Thomson[4] then briefly noted and figured some particularly striking forms of *Hyalonema* from the rich collection of the Challenger Expedition. One species, obtained in the vicinity of St. Thomas, from a depth of 390 fathoms, and named by Wyville

[1] *Loc. cit.*, pl. xxi. figs. 4, 5.

[2] *Archiv f. mikrosk. Anat.*, Bd. xi. p. 268.

[3] *Zeitschr. f. wiss. Zool.*, 1875, Suppl.-Bd. xxv. p. 142.

[4] The Atlantic, 1877, vol. i. p. 273.

Thomson *Hyalonema toxeres*, is distinguished by its remarkably strong, bow-shaped, spindle-like spicules.

In the same year, 1877, M. and J. Young[1] reported on fossil remains from the carboniferous strata of Cunningham Baidland, near Dalry in Ayrshire, which included not only the *Hyalonema parallelum*, M'Coy, already described by Süss, but a second species, *Hyalonema smithii*, Young and Young. Besides the long, straight, smooth, knitting-needle-like spicules which Süss refers to in *Hyalonema parallelum*, the Youngs found also short five-rayed and six-rayed spicules.

Among the sponges which A. B. Meyer brought home from the Philippines and New Guinea, and handed over to Bowerbank for description, there was a cup-shaped specimen which Bowerbank[2] briefly described in 1877, and in spite of the entirely distinct form of the spicules identified as a *Hyalonema* from which the basal tuft had been torn off. This he named *Hyalonema anomalum.* Dr. A. B. Meyer had the kindness to hand over to me at my request a portion of this same specimen belonging to the Dresden Zoological Museum, and I have been able to convince myself that we have here to deal *not* with a *Hyalonema*, but with a badly-preserved specimen of *Crateromorpha meyeri;* and with this the description given by Bowerbank himself agrees.

In the abundant sponge material which was collected during the deep-sea expedition by Agassiz and Pourtalés in the Gulf of Mexico, and entrusted to Oscar Schmidt for examination, this renowned spongiologist found only two specimens of *Hyalonema.*[3] The larger specimen consisted only of a torn off spicular tuft partly covered by a crust of *Palythoa.* The other, which was distinctly smaller, was however completely preserved, and bore a sieve-net over its upper extremity. The latter was identified by O. Schmidt as *Hyalonema sieboldii.*

In the Bay of Biscay, during the French expedition of the "Travailleur," a specimen of *Hyalonema lusitanicum* was dredged, according to Norman's[4] account, from a depth of 600 fathoms.

In the report by G. Armauer Hansen on the Sponges of the Norske Nordhavs Expedition, a badly-preserved Hexactinellid is described and figured (1885). It was obtained from a depth of 1081 fathoms, lat. 63° 17′ N., long. 1° 27′ W., on *Biloculina* clay. Armauer Hansen had for examination (*loc. cit.*, p. 19) "several specimens with round hollow stems of somewhat variable thickness, measuring up to 3 cm. in length, and surrounded at the one extremity by a very loose almost cotton-like substance." Since I observe a discohexact among the siliceous spicules figured (*loc. cit.*, pl. v. fig. 10), and since "the stem is composed exclusively of spicules which are truncato-spinose at both extremities," I can in no way agree with Armauer Hansen's opinion that this

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xx. p. 425.
[2] *Proc. Zool. Soc. Lond.*, p. 461.
[3] O. Schmidt, Spongien des Meerbusens von Mexico, 1879 and 1880, p. 64.
[4] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. vi. p. 436.

Hexactinellid, which he names *Hyalonema arcticum*, belongs to the genus *Hyalonema*. No *Hyalonema* possesses a "round hollow stem," with rough, rod-like spicules, rounded off at both ends; and in no *Hyalonema* are there rough discohexacts, such as are figured (*loc. cit.*, fig. 10*a*). On the other hand, I conjecture from the description and from the figures of Armauer Hansen that we have to deal with a species of my genus *Caulophacus*, and certainly at least with an Asconematid.

Character of the Genus.—The body is generally in the form of a thick-walled cup, from the shallow cavity of which a central conical boss projects. From the upper sharply defined border, which is distinguished by a fringe of marginal spicules, an independent sieve-net-like perforated membrane extends in many species over the whole oscular opening. From the centre of the lower, usually somewhat narrowed end of the body, a tuft of long and strongly developed basal spicules projects downwards. The tuft consists wholly or for the most part of four-toothed anchors, which serve to moor the sponge in the loose mud. The bundle of spicules is continued superiorly into the cone which rises in the gastral cavity. In most species, and perhaps even in all, the upper portion of this basal tuft is surrounded by an encrustation of *Palythoa*, which begins just below the end of the body proper, extending in different individuals to a very varied distance, but never growing on the lower somewhat bushy divergent portion of the tuft.

Both dermal and gastral skeleton are composed (1) of strong pentacts, with the unpaired ray sunk more or less deeply into the parenchyma, (2) of pinuli which have their tangential basal cross inserted in the skin, and (3) of amphidiscs which are radially disposed with the median axial cross portion embedded in the skin, and with one end projecting freely outwards, while the other extends into the parenchyma, or into the subdermal or subgastral spaces as the case may be. Amphidiscs more rarely occur tangentially in the skin, but are then represented only by minute forms. In some species the gastral skeleton is continued without much change into the efferent ducts, *i.e.*, into the canalicular skeleton. The parenchyma contains large and small oxyhexacts, cruciate tetracts, triacts, straight diacts, and occasionally isolated monacts.

The chambers are not so distinctly marked off as glove-finger or thimble-shaped sacs as in most of the other Hexactinellids. They appear rather as more irregular and less sharply defined diverticula of the membrana reticularis.

I shall divide the genus *Hyalonema*, Gray, into the two subgenera *Hyalonema*, sens. strict., and *Stylocalyx*—a distinction based on the presence or absence of an oscular sieve-plate.

Subgenus 1. *Hyalonema*, sens. strict. (Pls. XXVII.–XXIX.; Pl. XXX. figs. 9–17; Pl. XXXIII.).

The superior aperture of the gastral cavity is covered by a sieve-plate, which extends from the side (with its annular, cuff-like fringe of fine marginalia) either right across the mouth of the cup, or sunk down into the latter, towards the inner surface, in funnel-shaped fashion.

1. *Hyalonema sieboldii*, Gray (Pl. XXVII. figs. 1–13).

Among the numerous species of *Hyalonema* obtained by the Challenger Expedition, the familiar Japanese form, *Hyalonema sieboldii*, Gray, one of the best and first known Hexactinellids, was unfortunately not included. A collection of Japanese Hexactinellids, however, entrusted to me by Dr. Döderlein, contained a tolerably well-preserved dried specimen of this sponge, which is figured after a photograph (one-third natural size, not one-half as stated on the plate) on Pl. XXVII. fig. 1. I was able further to compare this with several dried and preserved specimens in the Royal Museum, Berlin, which were brought from Japan by Dr. Hilgendorf.

The total length of the specimens examined varies from 50 to 80 cm. The body proper measures 6 to 15 cm. in thickness, and occupies 10 to 15 cm. of the above total length, the remainder representing the length of the spirally twisted, basal tuft. The upper portion of the latter where it joins the body, and where, for a distance of 10 to 20 cm., it is beset by *Palythoa fatua*, M. Schultze, only attains a diameter of 5 to 10 mm. Gradually, however, the tuft becomes looser, and breaks inferiorly into a bushy bundle. Since the form and external appearance of the whole sponge have been already described and figured in detail by Max Schultze and others, I shall simply restrict myself to emphasizing the important points, and devote more attention to certain structural relations which have been hitherto less intimately investigated. The general form of the body is cylindrical, transversely truncated at the upper end, and inferiorly narrowed in a somewhat conical manner, rounded off, and finally ending in a small inconspicuous marginal pad. The superior external margin bears a fine fringe, composed of slender needles projecting in wreath-like arrangement (marginalia). The upper truncated surface is formed by a sieve-plate, which is stretched right across, or protrudes with a slight convexity. The component lattice-work of the sieve-plate is not, however, uniformly developed, but is usually divided into four distinct portions by four zones of unperforated membrane, which unite in the centre to form an irregular cross. The dividing zones measure from 3 to 10 mm. in breadth, and the four irregularly triangular or roundish perforated sieve portions vary in width from 2 to 4 cm. Each of the four perforated sieve-regions corresponds to an equal sized, deep portion of the gastral cavity, while the

imperforate limiting zones lie just above the gastral septa, and are indeed partially united with them. This union of the septa of the gastral cavity with the sieve-plate usually occurs only in the centre and at the outer ends, so that one can see the septa, in their middle portion, ending with a free convex margin just below the plate. In some cases, however, each septum unites along its whole extent with the corresponding zone of the sieve-plate. Commensal Anthozoa occur in extremely variable number all over the lateral surface, and even on the cruciate imperforate areas of the sieve-plate. They protrude from circular apertures, which are 2 to 3 mm. in width and possess a firm peripheral layer. In some specimens they cover the whole lateral surface so thickly that the distance between them is not more than from 3 to 10 mm., while they also occur abundantly (Pl. XXVII. fig. 2) on the dividing zones of the sieve-plate. In other specimens they occur singly only here and there, though they never seem to be wholly absent.

Apart from these Anthozoa tubes, the surface of the sponge is comparatively smooth. The pores of the dermal membrane covering the surface are for the most part microscopically small. The extreme inferior end of the body, adjacent to the *Palythoa* encrustating the basal tuft, consists of an inconspicuous but compact circular cushion, varying greatly in breadth in the different specimens. In dried forms, the fine reticulate pattern which is distinctly seen over the whole lateral surface of the body is in this region no longer recognisable.

When the terminal sieve-plate is removed, the gastral cavity is revealed, and is seen to be divided into four wide spaces by the four broad, cruciately disposed, radial septa, with a central conical elevation. The free upper margins of these septa, if not fused with the sieve-plate, are rounded off and convex, and extend from the body margin on the outside to the conical elevation in the centre. The cavities lying between the septa become gradually narrower downwards, and receive from the sides and from below the wide lacunar efferent canals of the body-wall. In a longitudinal section near the central axis, a continuation of the basal tuft is seen as a somewhat markedly twisted strand of spicules, prolonged up the central column and gradually narrowing towards the conical elevation, as was indeed long ago observed and figured by Max Schultze. Since the efferent canals are very wide and often lacunar, and since the subdermal spaces with the afferent canals penetrating inwards from them have a similar character, it evidently follows that the layer between the two systems of canals cannot be by any means broad.

The skeletal elements of *Hyalonema sieboldii* which always remain completely isolated were thoroughly studied in 1860 by Max Schultze, and so excellently described in his monograph, that I must here simply content myself with referring to that admirable memoir, and with a brief review of the different forms of spicules and of the manner of their disposition.

The parenchymal spicules supporting the soft body are represented by a large number of simple spindle-shaped diacts, varying in length up to 3 mm. Both their ends are simply pointed or rounded off, and not unfrequently provided with small spines. While most of these spicules appear to be smooth centrally, some exhibit there an annular swelling, and others two opposite, or four cruciate tubercle-like elevations, into which two or four cross branches of the axial canal are seen to penetrate. Even in the diacts which are smooth centrally sometimes similar cross branches from the axial canal can be detected.[1]

The spindle-shaped spicules are, for the most part, not perfectly straight but slightly bent, lying in strands or somewhat irregularly scattered. Slender diacts are also occasionally to be found beset towards both ends with inwardly directed hooks (Pl. XXVII. fig. 3). Between the spindle-spicules there is a somewhat sparse occurrence of proper oxyhexacts and derivative spicules, the latter with five to three rays, or even with two opposed at right angles. Larger smooth hexacts very rarely occur. Somewhat more abundantly, but yet rarely, slender hexacts are found with distally directed teeth, as represented in Pl. XXVII. fig. 13. Similar hexacts with curved rays (Pl. XXVII. fig. 10), as figured by Max Schultze (*loc. cit.*, Taf. iv. fig. 4), I have only very rarely seen—so rarely, indeed, that I doubt whether they have not found their way in from some other species of *Hyalonema*, and are not really foreign to *Hyalonema sieboldii*. I am also doubtful whether the peculiar amphidiscs, which were found so abundantly in the limiting membranes, are also proper to the parenchyma.

The dermal skeleton is mainly composed of strongly developed pentact hypogastralia, which form by their mutually apposed tangential rays a comparatively wide-meshed rectangular lattice-work, while the strands of the finer network of the skin are supported by tangentially disposed diacts. The narrowed ends of the somewhat blunt rays are frequently to some extent covered with tubercles, or are at least rough. They usually exhibit the same character on the same pentact, but in different spicules vary so far at least, that some are pointed and others quite blunt, some relatively smoother and others more or less markedly beset with terminal protuberances. The distal (sixth) ray has so completely disappeared that only the merest hint persists in the form of a slight prominence.

On the hypodermalia and on the dermal strands of diacts extended between them there are seen countless autodermal pinuli, which are here exclusively pentacts. The four basal rays intersecting at right angles lie wholly in the dermal membrane; the somewhat long distal ray, which is drawn out into a long fine point, is always at right angles to the surface of the skin, and thus projects freely into the water perpendicular to the body-surface. There is no proximal sixth ray, or its presence is

[1] M. Schultze, Die Hyalonemen, Taf. iii. and iv.

only suggested. The comparatively strong and straight basal rays, which are sparsely covered with small externally directed teeth, are only about 0·05 mm. in length. At first gradually narrowing, they end in a short conical point. The distal ray, which has an average length of 0·3 mm., is in some regions decidedly shorter, while it may, on the other hand, attain double the above length. It is as a rule perfectly straight, strongly developed at the base, and very gradually diminishing in diameter up to the fine narrow point. It is covered with strong, distally directed spines or teeth, which stand out somewhat markedly towards the base, and become shorter and more closely apposed towards the extremity (Pl. XXVII. fig. 12).

In some positions on the lateral surface of the body the pinuli are specially long and somewhat bent (Pl. XXVII. fig. 11). The dermal skeleton of the superior terminal sieve-plate does not differ in essential characters from that of the lateral wall. Instead of the large pentact hypodermalia, however, strands of diacts of various sizes predominate.

The marginalia forming the marginal fringe of the whole sieve-plate are straight or but slightly curved oxydiacts, 1 to 1·5 mm. in length. Four distinct, cruciately disposed, broad and rounded protuberances from the point of intersection represent the tangential rays. The freely projecting distal portion bears externally directed spines, and narrows very gradually to a fine point. The proximal portion, which is inserted in the parenchyma, is either smooth or but sparsely beset with small pointed elevations, which stand out transversely or are somewhat turned towards the apex, *i.e.*, internally. The proximal portion is always thicker and less pointed than the distal external portion, and its length is to that of the latter generally in the proportion of 1 : 2.

Though it cannot be doubted that these marginalia belong to the rank of the dermalia, and are most nearly related to the autodermal pinuli, no distinct transitional forms are to be observed; they can indeed be distinguished with equal sharpness from the pinuli of the sieve-plate and from those of the sides of the body.

Special attention must be directed to those remarkable elements of the dermal skeleton which were designated birotulate spicules by Bowerbank, and amphidiscs by Max Schultze and others. They consist of a straight main stem, both ends of which bear a similarly composed campanulate umbel formed of a varying number of radiate processes, varying in length, and either of a leaf-like form, or narrow like the ribs of an umbrella. This form of spicule is typical and characteristic of the whole family of the Hyalonematidæ. Manifold variations occur in shape and size, and these are partially characteristic of the different genera and species, and thus useful for diagnostic purposes. That we have here really to deal with diacts is evident, in spite of the absence of any intersection of the well-developed axial canal by one or two small transverse canals, from the fact that amphidiscs are not unfrequently found, in which four, cruciately disposed,

conical or rounded elevations project at the proper position. Here and there structures may be observed in which, instead of such rudiments of the four abortive rays, the latter, or at least two of them are present as well equipped with many-ribbed umbels as are the two rays usually alone developed. Carter has previously reported the occurrence of this abnormality in *Hyalonema sieboldii.*[1] I am inclined to compare the smooth processes forming the bell-shaped umbel at each end of the stem with the terminal rays of other spicules, and to regard them therefore as simple tooth or spine structures. I have never observed any trace of an axial canal within them, and find, with Marshall and others, that they are not formed in the first rudiment of the amphidiscs but develop subsequently. In *Hyalonema sieboldii* only two different kinds of amphidisc occur in the skin. On the one hand, there are large strongly developed amphidiscs, 0·42 mm. or more in length, with an umbel 0·13 mm. or more in breadth, the axial beam of which is 0·035 mm. in thickness, and more or less rough, with irregularly scattered, inconspicuously arched prominences. At each end there are about eight slightly arched umbel-rays, each of which, with a longitudinally directed basal piece about 0·07 mm. long and 0·015 mm. broad, springs from the side of the terminal portion of the axial beam, and passes externally into the ploughshare-like lateral plates, which are bent towards the surface of the umbel, and therefore at right angles to the basal plate (Pl. XXVII. fig. 7). These curved lateral plates do not usually grow together laterally, but form each a free sharp lateral border. They are continued at their free end into a lancet-shaped terminal point, while at the other extremity, near the main axis of the spicule, they end in a rounded prominence, and thus enclose between them a central terminal pit. The free margin of the basal plate exhibits a rounded edge which becomes gradually raised from the axial beam of the amphidisc, and is continued with a hook-like bend to the end of the lancet-shaped, curved, external lateral plate (Pl. XXVII. fig. 7).

The disposition of these large amphidiscs in the skin has not as yet been correctly represented by investigators. They do not lie, as Marshall, O. Schmidt, Bowerbank, Carter and others have described, tangentially in the dermal membrane, but are radially directed, so that one-half of the whole spicule projects freely from the external surface, and the other extends internally into the subdermal space. I have found them irregularly scattered, sometimes in comparative abundance, sometimes only sparsely, but could not distinguish any one region of the body as characterised by their special frequency. They occur also on the external surface of the terminal sieve-plate.

Besides these large amphidiscs with broad shovel-like umbel rays, numerous smaller forms, measuring only 0·01 to 0·016 mm. in length, occur, irregularly scattered in the dermal membrane, in no special direction, but for the most part tangentially disposed. Their umbels are terminally hemispherically curved, and consist of eight umbel-radii

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 372, and pl. xiii. fig. 22.

running out into straight terminal rays. The former vary greatly in length in the different amphidiscs, often hardly exceeding the length of the hemisphere, sometimes almost touching the opposite rays (Pl. XXVII. figs. 5, 6). The axial beam is sometimes comparatively smooth, sometimes knotted, frequently exhibiting at the middle point a cross or a ring of conspicuous knots. I have never found in the skin transitional stages between the two above described very different forms of large amphidiscs, but such intermediate structures are observed to occur in the parenchyma.

The *gastral skeleton* differs in many points from the dermal. The skin lining the principal gastral and the four large basal diverticula is not supported by pentacts, but by strands of large smooth diacts and monacts, which usually become gradually narrower towards the extremity, terminating in a sharp apex or conical point, or more rarely rounded off. The large amphidiscs, with broad, shovel-like, umbel-rays, which occurred so abundantly in the external skin, are here altogether absent; and their place is occupied by irregularly scattered, medium-sized forms with eight narrow, comparatively long rays, whose terminal portions are more nearly approximated to the axial beam (Pl. XXVII. figs. 8, 9). The length of these rays is about 0·3 mm., the breadth of the umbel 0·1 mm. The axial beam is comparatively narrow, and exhibits a few irregularly disposed tubercles, and usually, at the middle point, four cruciate strongly developed protrusions, which are probably to be regarded as traces of the abortive rays (Pl. XXVII. figs. 8, 9). The rays of the umbel resemble in general form those of the large amphidiscs in the external skin; they are, however, longer, measuring usually about a third of the whole length of the amphidisc. Originating in a short basal piece, they extend for the greater part of their length approximately parallel to the axis, or even with a slight external convexity. A comparatively large number of small amphidiscs occur like those of the dermal membrane figured on Pl. XXVII. figs. 5, 6, as also some rather larger isolated forms of similar structure, represented in fig. 4.

As in the external skin, pentact pinuli occur in abundance in the gastral membrane and in its direct continuation into the efferent passages and canals, where the lining membrane is covered with them. Compared with the dermal pinules, however, they are somewhat different in shape and less abundantly present. The basal cross lying in the limiting membrane consists of four weakly developed, and generally straight, rarely somewhat curved rays, almost twice as long as the basal rays of the dermal pinules, and beset with distally directed teeth. The ray which projects freely into the lumen and varies greatly in length, is likewise but weakly developed, and usually bears obliquely divergent, distally directed teeth.

The spicules which compose the basal collar-pad of the sponge body demand special notice. Besides the forms which have just been described in detail, structures occur in the parenchyma and in the dermal membrane of this region, which are not found else-

where throughout the whole sponge. They have the form of thick hexacts, pentacts, tetracts, triacts or diacts, whose rays, uniformly thick, strong and cylindrical—exhibit blunt or rounded ends, and are more or less abundantly covered with short, strong, conical spines. These teeth or spines are either uniformly scattered over the whole surface, or occur only on the distal ends of the several rays, the median and proximal portions remaining smooth. As these peculiar spicules of the basal pad have been figured in the case of *Hyalonema sieboldii* in Max Schultze's classic work on Hyalonematidæ, I have not devoted to them any special illustration.

Of all the skeletal parts of *Hyalonema sieboldii*, the long spicules of the basal tuft have been longest and most intimately studied. These basalia form a long loosely wound strand, which measures 30 to 60 cm. or more in length, and breaks up towards the foot in a brush-like fashion. To the detailed descriptions of former investigators I have but little new to add, and therefore refer to their accounts, especially to that of Max Schultze.[1] He found in one tuft 200 to 300 separate spicules, of which the shorter lay nearer the axis. The shape of the inferior extremity was certainly determined only in the shorter forms. He observed a simple pointed termination, similar to that of the superior extremity hidden within the sponge. Besides perfectly smooth forms, numerous spicules occur with a tooth-bearing spiral ridge. The free margin of the latter projects obliquely outwards and upwards, so that a similar direction is given to the leaf or nail-like, pointed or slightly rounded spines which it bears. Interruptions of the spirals sometimes occur, and these are often so regularly disposed, that the remaining portions of the projecting ridges are alternately opposed to one another.

On some very well-preserved (spirit) specimens collected by Dr. Hilgendorf in Sagami Bay, Japan, I was able to study the very inferior extremity of many of the long spicules of the tuft. It appeared that the spinose main portion of the spicule is followed by a short, narrow, smooth neck, which bears terminally a solid, cap-like or hemispherical thickening whose upper rounded margin exhibits eight recurrent teeth, forming an anchor-like figure.

2. *Hyalonema gracile*, n. sp. (Pl. XXVII. figs. 14–23).

This species of *Hyalonema* was dredged in the neighbourhood of the Philippine Island Mindanao (lat. 8° 0′ N., long. 121° 42′ S., Station 211), from a depth of 2225 fathoms, and on a blue mud ground. Its body, which is approximately pear-shaped, measures 2·5 cm. in length by 1·6 cm. in breadth. The upper end, which is somewhat narrowed and transversely truncated, bears a delicate sieve-plate, while the lower, conically pointed end runs out into a basal tuft, 1·5 mm. broad and about 3 cm. long. The component spicules are not numerous, nor twisted, and they diverge but slightly

[1] Die Hyalonemen, Taf. ii. figs. 1–7.

inferiorly. Owing to the insufficient preservation of the single specimen, it was impossible to determine whether a *Palythoa*-crust enveloped the basal tuft, below the inferior extremity of the body. Below the superior terminal sieve-plate, there is a flat hollow space, from which four cruciately arranged wide passages, furnished with lateral and terminal diverticula and canalicular prolongations extend into the parenchyma. Nearly up to the sieve-plate, the centre is occupied by a columella, ending freely in a conical prominence. From this central pillar the four cruciately arranged septal plates radiate outwards, separating the four gastral spaces from one another (Pl. XXVII. fig. 14).

Of the external skin, as also of a delicate narrow cuff-like fringe which surrounds the sieve-plate and separates it from the skin, only a few pieces are preserved.

The spicules supporting the parenchyma consist of simple, flat oxyhexacts of medium size, which are usually radially disposed at right angles to the surface, and distributed with general uniformity over the whole body. The six rays are all of equal length, and are very gradually narrowed towards their somewhat conically pointed extremities. Besides these, numerous simple smooth oxydiacts occur, partly isolated, partly disposed in strands. These sometimes exhibit a central swelling, either in the form of a simple ring, more or less sharply marked off, or in the form of four cruciate, or more rarely of two opposite roundish protuberances. In these well-developed central portions an axial-canal cross can usually be seen. Less abundantly than these diacts, triacts occur, which generally exhibit two long rays, lying in one axis, and a much shorter third ray, at right angles to the former and springing from a slight median swelling.

Near the narrowed end of the body, and especially in the porous basal cushion, hexacts, pentacts, tetracts, triacts and diacts occur, with cylindrical rays, which do not run out to a point, but exhibit a truncated or even swollen end, and are terminally, and to a greater or less distance inwards, thickly beset with conical tubercles. As an illustration of the peculiarly modified spicules of the basal cushion, I have figured a triact on Pl. XXVII. fig. 18. Tetracts are there, however, most abundant.

I have here and there found such a simple regular form of small oxyhexact, with delicate narrow rays, as is represented in Pl. XXVII. fig. 20. Very frequently, on the other hand, and throughout the whole parenchyma, such forms occur as are seen in Pl. XXVII. fig. 23. The long narrow rays, covered with small, not oblique but directly transverse protuberances and peaks, are more or less markedly bent round in their distal portions, and the bendings of the two rays which lie in the same axis are always in the same plane, but in opposite directions. The planes of curvature of the three axes of the spicule form with one another equal angles of 120°. The representation of these hexacts with curved rays in Pl. XXVII. fig. 23 is so far unsatisfactory, since one cannot recognise in it that three rays are approached by their ends, and their three

opposites likewise. This is, however, better expressed in the figures of corresponding spicules in other species, *e.g.*, *Hyalonema apertum* (Pl. XXXVIII. fig. 5).

The dermal skeleton is composed of large, strong, hypodermal pentacts, of autodermal pentact pinuli, and of autodermal amphidiscs of various kinds. The rays of the hypodermal pentacts are quite smooth and are directed at right angles to one another. They either run gradually to a sharp point or terminate conically. There is no hint whatever of the missing distal ray. The proximal ray is usually larger than the four equal-sized tangentials, but is sometimes smaller, and sometimes of equal length. The autodermal pinuli are pentacts. The proximal ray is no longer recognisable, but the distal is drawn out into a slim fir-tree-like form, about 0·3 mm. long, and beset with obliquely inserted and somewhat bent and pointed branchlets (Pl. XXVII. fig. 21). The basal end of the distal ray usually remains perfectly smooth. The four tangential rays, which lie at right angles to one another and to the distal ray, are straight and of equal size. Only near the somewhat blunt distal extremity do they exhibit some distally directed protuberances, while the large proximal portion of each ray is quite smooth (Pl. XXVII. fig. 21).

The very large kind of amphidisc which occurred in *Hyalonema sieboldii* is not present in this species. The largest form of amphidisc has a length of 0·14 mm. and a breadth of 0·06 mm. The axial rod is covered with protuberances, the highest of which are in the middle, and arranged in a circle. The eight terminal umbel rays on each side, which are disposed in a bell-like form, have a leaf- or spade-like shape, and terminate in a somewhat rounded lancet-like point. The basal plate is comparatively short. The individual terminal rays are sometimes laterally separated at their base by grooves, but sometimes, on the other hand, they are laterally united. The terminal arching of the bell-shaped umbel is not very broad, though strongly marked as the result of the divergence of the umbel rays. The extremities of the opposite umbel-rays approach one another to within a fourth of the whole length of the amphidisc. These larger amphidiscs always have their median portion inserted in the dermal membrane, so that the one half lies within the body of the sponge, while the other projects freely above the surface of the skin; but, besides these, several other smaller forms occur as represented in Pl. XXVII. figs. 15, 16, 17. These all exhibit a relatively broad arching of the much shorter terminal umbels, some of which consist of more than eight umbel rays. I have observed as many as thirteen umbel-rays in some of the medium-sized amphidiscs (Pl. XXVII. figs. 16, 17). The axial rod either exhibits a few small, irregularly distributed tubercles, or in addition to these four coarser, cruciately arranged, median prominences, which may also occur alone. The umbel-rays have narrow bases, they end in lancet-like fashion, and approach one another to the extent of not more than one-third of the total length (0·03 mm.) of the amphidisc. I never found these median and smaller amphidiscs except lying flat, that is, parallel to the surface of the dermal membrane.

The skeletal elements of the gastral membrane and lining of the efferent canals agree in many respects with those of the dermal area. The hypogastral *pentacts* are, however, wanting, being either replaced by diacts or not at all. The autogastral pentact pinules generally resemble the dermals in form and length; they are, however, throughout more delicate and slim (Pl. XXVII. fig. 22). They are at once thickest and strongest near the margins of the openings, and are seen to be more widely separated and more weakly developed the further the canals are traced inwards.

The long narrow diact marginalia in several layers, form a not very high, cuff-like projecting marginal fringe. From the middle portion, which is distinguished by four cruciate protuberances with axial canals, a smooth, gradually narrowing, terminally pointed proximal ray extends inwards, while, in the opposite direction, an equally long, or still longer distal ray, projects freely outwards in the same axis. The basal portion of the latter is smooth, but the larger portion, on to the freely projecting terminal point, is furnished with pointed, distally-directed lateral teeth, gradually decreasing in size.

In the basal pad, strong short spicules occur, with from six to two thick, cylindrical rays, whose terminal portions are frequently somewhat thickened, and always covered with radially disposed, pointed, conical teeth. Of the apparently smooth basal spicules which form a simple, untwisted tuft, but few are present, and these all broken.

3. *Hyalonema divergens*, n. sp. (Pl. XXVIII. figs. 1–11).

This species of *Hyalonema* was dredged in Mid-Pacific, to the east of Maldon Island (Station 271), lat. 0° 33′ S., long 151° 34′ W., from a depth of 2425 fathoms, on a Globigerina ooze ground. In shape it resembles an inverted bell, with a slightly widened terminal portion; it possesses a length of 8 cm. and a maximum breadth of 6·5 cm. (Pl. XXVIII. fig. 1). The superior margin of the transversely truncated terminal surface bears a delicate spicule-fringe. The terminal surface itself is formed by a transversely stretched net, that is, by a typical sieve-plate. From the somewhat pointed lower end a straight basal tuft projects. It is composed of parallel basal spicules, which are, for the most part, broken somewhat short, and sometimes attain the thickness of almost a millimetre.

The only specimen procured is somewhat compressed, and in some places rubbed away, so that it is impossible to make any definite statements as to the characters of the lateral surface. Only here and there does a patch of uninjured skin persist. At the inferior extremity of the body, where the long, strong spicules of the root-tuft freely project, the often mentioned thick basal pad is seen. There is no trace of encrusting *Palythoa*, but the general state of preservation makes it impossible to say with certainty that the *Palythoa* were absent during the life of the sponge.

The delicate net of the terminal sieve-membrane is raised from the marginal portion

of the upper surface of the thicker parenchyma of the body, and is also quite free from the four cruciate septa and the central pillar, though it may possibly have coalesced with the distal portions of the upper margins of the septa and with the end of the columella. From the four large principal cavities of the efferent system, ramified lacunæ and canals lead to the sides, and downwards into the recesses of the sponge, so that, as in *Hyalonema sieboldii*, the whole body-mass consists of a very wide-meshed system of plates.

The great majority of the spicules of the parenchyma are straight or slightly bent, smooth diacts, with or without central knot or swelling. Between these, smaller isolated regular oxyhexacts occur, with straight, smooth rays (Pl. XXVIII. fig. 8), and also somewhat larger oxyhexacts with bent rays (Pl. XXVIII. fig. 6). The representation of these forms in Pl. XXVIII. fig. 6 is so far unfortunate, since each of the two opposite triplets of rays should have the three ends of the rays approximated.

In the dermal skeleton the strongly developed hypodermal pentacts of different sizes, and with simple, smooth, somewhat pointed rays, are to be noted. The four tangential rays of the latter are equipped with numerous pentact pinuli exhibiting strong, short, slightly pointed or even blunted, smooth, straight basal rays, and exhibiting a strikingly long, well-developed distal ray, furnished with somewhat closely set teeth (Pl. XXVIII. fig. 7). The freely projecting, toothed distal rays attain the length of 1·3 mm. or more. The amphidiscs, which are present in considerable abundance, exhibit considerable varieties of form and size. Most of them are 0·13 mm. in length, and exhibit a long narrow axial rod with tubercles and frequently with larger cruciately disposed protuberances in the centre. The eight tolerably broad, lancet-shaped umbrellar rays attain a length of about a third of the whole amphidisc, and extend, with marked divergence, in an incurved but oblique outward course (Pl. XXVIII. fig. 3). In reference to this striking divergence of the umbrellar rays in the largest amphidiscs, I have bestowed on the species the title *Hyalonema divergens*. Among these amphidiscs disposed at right angles to the limiting surface, others of a very large size occur here and there. The latter attain a length of 0·5 mm., and have long umbrellar teeth curved into the form of a long ovoid. From the middle of the delicate axial rod, four somewhat long, cruciately disposed tubercles project. Among the numerous amphidiscs with curved umbrellar rays, medium-sized forms, 0·06 mm. in length, are also found, with knotted axial rods, and hemispherical arched umbels (Pl. XXVIII. fig. 4). Small forms are also abundantly present, measuring 0·03 to 0·04 mm. in length, and exhibiting short, hemispherical terminal discs (Pl. XXVIII. fig. 5). These smaller and smallest amphidiscs are not disposed at right angles to the surface, but lie tangentially in the dermal membrane.

The marginalia are long narrow diacts 2·2 mm. in length, with simple, smooth, or only inferiorly roughened surfaces. The proximal ray is uniformly narrowed and runs out to

a point; the free distal is at least twice as long, and bears short spines. At the boundary of the two, in the centre of the diact, are four conical projections arranged in a circle (Pl. XXVIII. fig. 2). The gastral skeleton was not well preserved; but it seemed not to differ essentially from the dermal.

4. *Hyalonema toxeres*, Wyville Thomson (Pl. XXIX.).

Near the West Indian island St. Thomas (Station 24), lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W.; several specimens of a *Hyalonema* were dredged from a Pteropod ooze ground at a depth of 390 fathoms. The species has already been shortly described by Sir Wyville Thomson in his preliminary account of the Voyage of the Challenger—The Atlantic. I subjoin the account there given of this form.[1]

"Two examples of the sponge-body of a very handsome *Hyalonema* were sifted out of the coral mud. Unfortunately, in both cases, the sponge had been torn from the central coil, and the absence of the coil might have thrown some little doubt upon the form and mode of finish of the complete animal; so that it was extremely fortunate that a young specimen of the same species, about 40 mm. in length, was caught in the tangles quite perfect."

"*Hyalonema toxeres*, Wyville Thomson, resembles closely the other known species, *Hyalonema lusitanicum* and *Hyalonema sieboldi*, in general appearance and in the arrangement of its parts. A more or less funnel-shaped sponge presents two surfaces, covered with a network of different patterns formed by varying arrangements of large five-rayed spicules. The upper concave surface shows a number of oscular openings irregularly arranged, and the lower surface a more uniform network of pores, some of which seem to be inhalent and others exhalent. The central axis of this sponge is closely warped into the upper part of a coil of long and strong glassy spicules, which, as in the other species, serve to anchor the sponge in the soft mud. Both of the specimens dredged have the sponge more flattened and expanded than it is in *Hyalonema lusitanicum*. In one of them it is nearly flat (fig. 5), forming a uniform cake-like expansion, 80 mm. in length, by 70 mm. in width, and about 8 mm. in thickness. The upper or oscular surface is covered by an exceedingly close network, with groups of large openings at nearly equal intervals. It is slightly raised in the centre. The central elevation is followed by a slight depression, and the upper wall then passes out nearly horizontally to a sharp peripheral edge, fringed with long, delicate spicules, each consisting of a slender central shaft, with a cross of four short transverse processes in the centre. The outer half of the central axis is delicately feathered.

"The lower surface of the sponge (fig. 6) is protected by a singularly elegant

[1] *Loc. cit.*, vol. i. p. 273.

network of sarcode, with wide oval and round meshes radiating irregularly from a central point. The membrane is transversed by irregularly radiating ridges of firmer substance, which unite in the centre in a projecting boss at the point, where in this specimen the 'glassrope' has unfortunately been torn out.

"In minute structure, *Hyalonema toxeres* corresponds in all essential respects with *Hyalonema sieboldii* and *Hyalonema lusitanicum.* All the spicules are of the same ground forms, with some little differences in detail, with the exception of one remarkable spicule which enters largely into the structure of *Hyalonema toxeres,* and serves to distinguish even the smallest portion of it. This is a large spicule, the largest above a centimetre in length, and more than half a millimetre in width in the centre, shaped

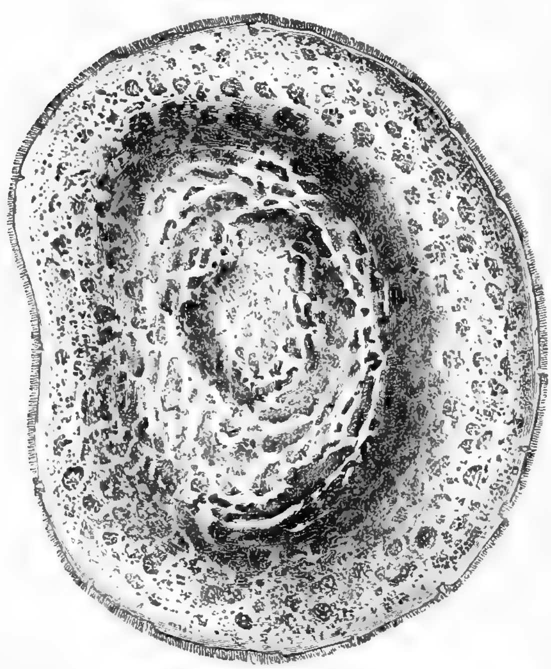

FIG. 5.—*Hyalonema toxeres*, Wyville Thomson. Upper (after W. Th.) surface, natural size.

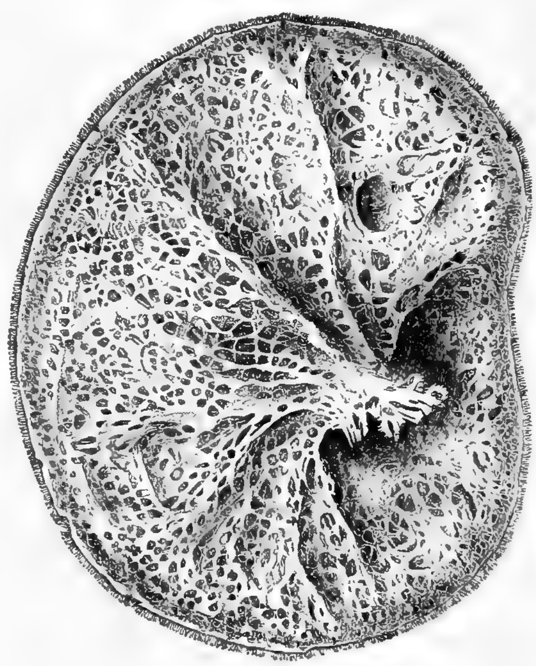

FIG. 6.—*Hyalonema toxeres*, Wyville Thomson. Lower (after W. Th.) surface of the sponge, natural size.

like a bow or boomerang. These spicules are distributed in all parts of the sponge, and are particularly abundant near the insertion of the coil. No analogous form occurs in the other species of *Hyalonema.*

"The large amphidiscs are much larger than in any other known sponge. They are upwards of half a millimetre in length and visible to the naked eye, twice as large as in *Hyalonema lusitanicum.* The feathered shafts of the five-rayed spicules which fringe the openings are longer than in the other species, and the rays of the cross are much shorter (fig. 7).

"The second specimen of the sponge body agreed with the one described in all

essential points of structure, but was more conical in form. The young specimen differed from the young of *Hyalonema lusitanicum* at the same age in being wider and more cylindrical, but the external wall, which afterwards becomes that of the lower surface, showed the same arrangement in squares which we find in the young of the other species, so that apparently the graceful, round-meshed, wide netting of the under surface does not appear in the early stages.

"The coil is developed much in the same proportion and in the same way as in *Hyalonema lusitanicum*, the fibres spreading out and incorporating with the sponge substance. The characteristic bow-like spicules are abundant in the young sponge, and

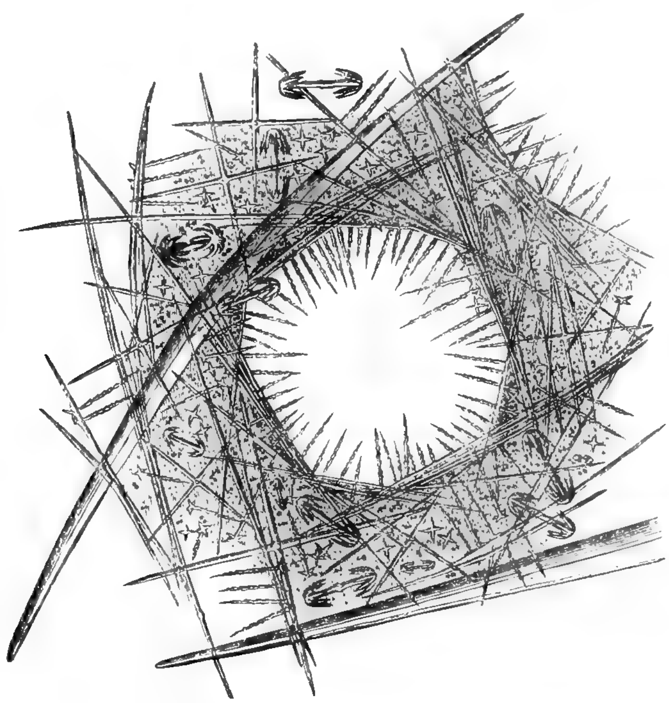

FIG. 7.—*Hyalonema toxeres*, Wyville Thomson. Part of the membrane from the upper surface, × 40.

these, with the larger amphidiscs, place it beyond a doubt that it is the young of *Hyalonema toxeres*.

"A quantity of loose spicules brought up in the dredge at the same time were referred to this species. They were somewhat stouter than those of *Hyalonema lusitanicum*, and less regular in outline. There was one coil nearly complete, involved in a calcareous expansion of a branch of *Diplohelia profunda*. Two very young polyps, apparently of *Palythoa fatua*, were commencing the formation of their investing crust at the top of the coil of the young specimen, just below the sponge body."

Since the three specimens studied by Wyville Thomson are also at my disposal for

examination, though perhaps in a less satisfactory state of preservation, I will add to the above account some supplementary details.

The smooth cake-like specimen figured by Wyville Thomson (figs. 5, 6) was not when I received it so well preserved as it appears in the woodcuts referred to. The specimen is represented in Pl. XXIX. figs. 2, 3, of the natural size, after a photograph from either side. It is evident that half the fringed margin (from which a rectangular portion has been cut for investigation) is well preserved, while the rest of the marginal portion seems compressed and torn. The side represented in fig. 3, covered with a somewhat wide-meshed network of more or less thin strands, exhibits a tolerably uninjured surface, and is almost smooth with the exception of the projecting knobs about the centre of the (uninjured) disc. On the other side, however (fig. 2) the marginal portion exhibits for about a finger's breadth an intact dermal layer, with a fine-meshed lattice-work, through which were seen the large deep apertures or pits of the parenchyma, occurring at uniform distances of about 5 to 8 mm., as figured in the woodcut (fig. 5) of Wyville Thomson's Atlantic. The middle portion of the flat sponge body is on the same side much injured and apparently compressed (Pl. XXIX. fig. 2).

From Wyville Thomson's account this latter somewhat inbent side (Pl. XXIX. fig. 2 of my figures, and fig. 5) is said to be the upper, while that covered by the wide-meshed sieve-net and bearing a projecting central boss be the lower (Pl. XXIX. fig. 3, and fig. 6). The projecting central protuberance of the latter is, according to Wyville Thomson, the narrowed basal portion, from which the long tuft of needles was torn away.

The results of my investigation force me, however, to another conclusion, namely, that the side covered with the wide-meshed sieve-network is the upper, while the other with the fine superficial lattice-work and the subjacent pits of the parenchyma is the lower or outer. This is proved first of all by the character of the superficial layers. The wide-meshed framework which covers the surface (fig. 3) exactly resembles the sieve-plate present in the funnel-shaped second specimen (Pl. XXIX. fig. 1) of the same species, while the fine-meshed dermal layer which covers the undamaged marginal zone on the other side (Pl. XXIX. fig. 2) corresponds exactly in structure to the dermal membrane of all Hexactinellids and especially to that of the funnel-shaped specimen (Pl. XXIX. fig. 1) of the same species.

The boss-like elevation in the centre of the surface furnished with the wide-meshed network does not represent the narrowed basal end of the body, but the conus centralis which occurs on all species of *Hyalonema*. The narrowed basal end of the sponge body has, on the other hand, been torn off with the basal tuft of spicules, and is therefore not to be seen on the lower surface of the body (Pl. XXIX. fig. 2). We have here apparently a specimen of *Hyalonema toxeres*, which, after the tearing away of the basal tuft and lower end, has been forced by oblique pressure into a flat compressed form. The normal

form of the body as seen in the second specimen, which is comparatively well preserved, but also destitute of basal tuft, is represented in natural size in Pl. XXIX. fig. 1. We have here an inverted conical form, with slightly bulging sides, and a broad upper end not transversely truncated, but depressed in funnel-like fashion, and covered by a narrow-meshed delicate network, while the external lateral surface of the body is enveloped by a delicate dermal sieve-work—the dermal membrane, through which the more or less regularly distributed large inhalent canals of the afferent system are seen as dark spots (Pl. XXIX. fig. 1). On the upper external margin, which projects as a sharply defined ring, there is a continuous fringe of marginal spicules. On the lower, somewhat incurved end, lies a round gaping opening, about 6 mm. in width. This leads into a straight canal, and there can be no doubt that it represents the position of the torn off basal tuft.

The third much smaller specimen, with a well-preserved tuft of basal spicules, as also figured by Wyville Thomson, differs essentially in external form from the above specimens. The body is not conical but oval, with truncated superior, and somewhat narrowed inferior extremity. The structure, however, agrees so exactly with that of both the other specimens, that one can have no hesitation in acknowledging the correctness of Wyville Thomson's reference of this form to the same species, *Hyalonema toxeres*. The specimen is unfortunately not well preserved, especially towards the upper end. On the middle of the upper terminal surface the conus projects, and from it four cruciate longitudinal septa with smooth, convex, superior margin extend through the central space to the lateral wall into which they pass. The four cruciate cavities thus formed are continued downwards and sideways into the efferent lacunar passages of the parenchyma. Close beneath the narrowed inferior portion with the small basal tuft there is a ring of a few *Palythoa* individuals (Pl. XXIX. fig. 4).

Microscopic examination of the flinty spicules shows the intimate similarity of all the three specimens, and the few variations which are present are referable to differences in age and individual characteristics.

In the parenchyma, besides the familiar regular medium-sized oxyhexacts, and numerous straight or slightly bent, weakly developed diacts with or without central swellings or knobs, especially remarkable and characteristic diacts occur. These are thick and spindle-shaped, curved or somewhat bent, with rounded terminal points, and without central swelling or tubercles. These bent needles measure 3 to 8 mm. in length, and exhibit in the middle a thickness of 0·3 to 0·4 mm. The concentric lamination is very distinctly seen, and on the outer end the relation of the various layers of growth is often most beautifully demonstrable (Pl. XXIX. fig. 11). The distribution of these strong, bent needles in the parenchyma seems to me quite irregular. I have not observed their special abundance in any one region, nor on the other hand any definite disposition. They frequently occur parallel to the skin near the external surface, but also in

the middle of the parenchyma, and in the most varied relations to the dermal surface. In contrast to most other species of *Hyalonema*, small oxyhexacts with straight (Pl. XXIX. fig. 9) and with bent (Pl. XXIX. fig. 10) rays are not abundant. The latter occur indeed in very sparse isolation. Both forms are characterised by this, that the rays are throughout their whole extent thickly beset with small barbs, turned obliquely inwards, *i.e.*, towards the middle.

The dermal skeleton is supported by medium or small-sized, simple, smooth, hypodermal oxypentacts without a trace of a distal sixth ray, and also by numerous medium-sized hypodermal oxydiacts, which all lie tangentially. Above these hypodermalia, autodermal pentact pinuli occur, which exhibit short, slightly toothed, basal rays of moderate strength, and a narrow distal, 0·4 to 0·5 mm. in length, with somewhat long narrow obliquely inserted, pointed lateral spines. Large dermal amphidiscs, 0·35 mm. in length (Pl. XXIX. fig. 6) are tolerably abundant. In their breadth and in the somewhat flatly arched short terminal umbels, with eight broad, lancet-shaped, umbel rays, they at once recall the approximately equal, strong dermal amphidiscs of *Hyalonema sieboldii*. They are all disposed at right angles to the surface, with their centre in the dermal membrane (Pl. XXIX. fig. 5). Besides these, numerous smaller amphidiscs with short hemispherical terminal umbels (Pl. XXIX. fig. 8) occur in tangential disposition. Less frequently medium-sized amphidiscs occur, essentially resembling the greater above described (Pl. XXIX. fig. 7).

In the sieve-membrane covering the superior terminal surface of the sponge, and to a large extent coalescent with the subjacent parenchymal layer, skeletal elements occur similar to those in the external skin. The inner surface of the large lacunæ and passages penetrating the parenchyma, and also of the efferent canals is here *smooth*, exhibiting *no* gastral or canalicular skeleton, containing neither hypogastral pentacts nor pinuli nor amphidiscs, in fact, solely supported by weakly developed, somewhat curved diacts like those which occur so abundantly in the parenchyma.

The marginalia, which form a continuous projecting fringe on the sharp upper margin of the body, are straight oxydiacts, whose proximal end inserted in the parenchyma is smooth, while the much longer and very gradually pointed distal end is beset with lateral spines projecting obliquely downwards (Pl. XXIX. fig. 5). At the boundary between the distal and proximal portions, four cruciately disposed hemispherically arched knobs project, being traces of the rudimentary transverse rays.

The basal pad of the smaller (Pl. XXIX. fig. 4) and of the large funnel-shaped specimen (Pl. XXIX. fig. 1) consists of six- to two-rayed, strongly developed spicules, with cylindrical, externally truncated, or rounded straight rays. These agree thoroughly with similar structures in the hitherto described species of *Hyalonema*. The proximal portion of each ray is smooth; the distal, on the other hand, is thickly beset with coarse conical spines; more rarely the whole surface of the spicule is uniformly spinose.

The long basalia of the root-tuft which I examined in the small specimen (Pl. XXIX. fig. 4) exhibit opposite or spirally disposed, obliquely projecting ledges with marginal teeth, like those which M. Schultze has figured in *Hyalonema sieboldii* in his well-known work (Taf. ii. fig. 4). The extreme distal end of the long basalia was not preserved.

5. *Hyalonema kentii*, O. Schmidt (Pl. XXX. figs. 9–17).

In his Spongien des Meerbusens von Mexico, O. Schmidt describes (p. 65), under the designation *Asconema kentii*, a Hexactinellid which was dredged at various localities off Grenada, Martinique, Guadeloupe, and Bequia, from depths of 300 to 1500 fathoms. This form occurred in two varieties, on the one hand, as a "flat or shallow bowl, either rounded off inferiorly or furnished with a short or somewhat irregularly twisted pointed stalk," and on the other, as "a saccular form with irregular margin, divided internally into irregular pouch-like divisions and cavities, separated by thin ragged partitions." "A delicate outer layer with fir-tree-like spicules, extends like a fine veil over the surface. The body is unusually rich in double verticils (Doppelquirrlen), occurring in very varied dimensions and forms in the several parts of the body." As my esteemed fellow worker in Strassburg was kind enough to give me for examination a dried specimen of the goblet-type, I am able to include this beautiful form in the series of species of *Hyalonema*. A figure, drawn from a photograph, represents the sponge of the natural size. Both the external and the concave superior and internal surface of the loose cup- or funnel-shaped body are covered by a delicate reticulate membrane. On the outer wall this network is much finer and more uniform than on the concave upper surface, where it seems to form a sieve with unequal, and in some cases, large meshes. It is either attached to the subjacent body parenchyma, or extends freely across the large cavities. On the superior external margin there is, as O. Schmidt pointed out, a cuff-like fringe of fine spicules.

The loose parenchyma of the sponge is supported by numerous straight or curved smooth oxydiacts, with or without rudiments of the four abortive transverse rays, and by smooth, simple, medium-sized oxyhexacts, which frequently exhibit a slight roughness, and are furnished either with straight or with curved rays as represented in Pl. XXX. figs. 14, 15. It is noteworthy that the oxydiacts are generally thin and often so long that they become readily curved, not unfrequently appearing much bent or even coiled.

The hypodermal oxypentacts are perfectly smooth. Their tangential rays are mutually apposed and form a beautiful rectangular meshwork. To these rays are attached a great number of autodermal pinuli, with four straight, somewhat substantial, basal rays which are comparatively short, conically pointed, and either quite smooth or equipped terminally with minute distally directed teeth. The distal ray, on the other hand, measures about 0·45 mm. in length, is smooth at the base, but elsewhere

so thickly beset with rather long, narrow spines, diverging obliquely outwards, that a somewhat bushy appearance results (Pl. XXX. fig. 16). An essentially different appearance is presented by the pinuli which lie on the funnel-shaped concave upper surface, in the strands of the sieve. The basal rays are here narrower and longer; the weakly developed distal ray has a decidedly greater length—0·8 mm., and bears only a small number of short apposed spines (Pl. XXX. fig. 17). On the inner surface of the gastral cavity and wider efferent canals, a special gastral or canalicular skeleton occurs. This consists of moderately large, smooth, simple oxypentacts, with the four transverse rays inserted on the gastral or canalicular membrane, and sparsely furnished with slim autogastral pinuli of various sizes. The four straight basal rays of the latter are rather long and thin, and gradually pointed; the distal ray is slim and beset with short, somewhat apposed, lateral spines.

Among the dermal amphidiscs there frequently occurs a large, comparatively broad form (0·5 mm. long by 0·2 mm. broad), with short, much arched umbels, and eight broad lancet-shaped umbel rays. The strongly developed axial rod is for the most part smooth, but generally exhibits at the middle point four cruciately disposed, rounded tubercles,—the remnants of the four abortive transverse rays. In the superior sieve-plate these large broad amphidiscs which occur all over in the external skins are, curiously enough, absent. On the other hand, medium-sized (0·3 mm.) amphidiscs of another form occur, with narrow, much arched, eight-rayed umbels, which occupy more than a third of the total length, sometimes almost meeting in the middle. The slim axial rod is beset with tubercles (Pl. XXX. fig. 11). Besides these, somewhat smaller and narrower amphidiscs, with eight medium-sized umbel rays occasionally occur, and in great numbers the decidedly smaller forms with short, broadly-arched many-rayed umbels which occurred so abundantly in the external skin (Pl. XXX. fig. 13).[1]

In the basal pad the familiar strongly-developed six- to two-rayed spicules occur abundantly. Their rounded ends are covered with tubercles, while the proximal main portion of the ray is smooth. The bundle of needles in the basal tuft is unfortunately torn away. At the inferior extremity of the body one can see the distinct defect left by their removal.

Hyalonema poculum, n. sp. (Pl. XXXIII. figs. 1–7).

In the neighbourhood of the island of Juan Fernandez, west of Valparaiso (lat. 33° 42′ S., long. 78° 18′ W., Station 300), a cup-shaped *Hyalonema* was dredged from a Globigerina ooze bottom at a depth of 1375 fathoms. The inferior extremity and tuft of basal needles is torn away. The upper funnel-shaped concave end of the comparatively thin-walled cup has a transverse diameter of about 5 cm., while the lower

[1] Too few rays have been represented in Pl. XXX. fig. 13. There are from thirteen to sixteen.

broken portion measures about three. From this it may be inferred that the whole body had a length of about 10 to 12 cm. On the superior somewhat sharply terminated margin there is a continuous border-fringe of projecting spicules. The skin of the upper surface of the funnel is gradually raised to a distance of about 1 cm. from the body-parenchyma as an independent lattice-work (Pl. XXXIII. fig. 1). On the external surface traces are seen here and there of the narrow-meshed rectangular network of the dermal membrane.

In the parenchyma lie numerous long, thin, and somewhat pliable oxydiacts, on which central tubercles or nodes are generally absent, or but slightly developed. Between these, some medium-sized and numerous small, straight, regular oxyhexacts occur; the rays of the latter exhibit a slight roughness (Pl. XXXIII. fig. 7). I have not found any small oxyhexacts with bent rays. The dermal skeleton is characterised by the presence of moderately large strongly developed hypodermal oxypentacts. The four tangential rays bear autodermal pinuli with four short, strong, almost smooth basal rays, and a moderately long, somewhat markedly spinose distal (Pl. XXXIII. fig. 6). Dermal amphidiscs are represented by a somewhat large (0·5 mm. in length) form with broad, short, hemi-spherically arched umbels, and with four or eight nodes at the middle of the axial beam. The eight umbel rays are pointed like lancets, and not broadened out in shovel-like fashion (Pl. XXXIII. fig. 4). I sometimes observed the sharp lateral margin of several somewhat longer umbel rays uniformly beset with fine teeth in a saw-like fashion. Besides these, the familiar small amphidiscs with short, flat, or hemispherically arched umbels occur in great abundance, and also isolated medium-sized thinner forms with eight to ten umbel rays.

The skeletal elements of the lattice-work covering the upper surface of the funnel agree essentially with those of the skin.

The marginalia measure 0·6 mm. in length; the distal ray is covered with spines like that of the pinuli; the proximal ray is smooth. In the centre are seen four cruciately disposed, somewhat distally directed, bent tubercles with fine terminal points (Pl. XXXIII. fig. 3).

Hyalonema conus, n. sp. (Pl. XXXIII. figs. 8–15).

South of Australia (lat. 50° 1′ S., long. 123° 4′ E., Station 158) a form of *Hyalonema* was dredged from a Globigerina ooze bottom at a depth of 1800 fathoms. The basal tuft was again torn away, but the rest of the body was otherwise tolerably intact. A portion of a basal tuft with a small remnant of attached body was also found, and very probably belonged to the same specimen. The body has the form of a cone, 6 cm. long by 5 cm. broad at the upper transversely truncated end, while the lower round end narrows to about the thickness of one's little finger (Pl. XXXIII. fig 8). The somewhat incurved

upper terminal surface is covered by a terminal sieve membrane lying flatly over the parenchyma of the body. Round about this sieve-plate, on the somewhat sharp lateral margin, an inconspicuous circular fringe of spicules projects. On the lateral surface of the cone, remnants of the delicate dermal lattice-work are here and there recognisable (Pl. XXXIII. fig. 8), and through the latter large grooves and inhalent apertures are visible.

The parenchyma is supported by medium-sized smooth oxyhexacts and by numerous thin and pliable oxydiacts of various sizes, with or without central swelling. More rarely diacts occur with one or two club-shaped swollen ends. Straight, smooth, small oxyhexacts occur in moderate abundance.

The dermal skeleton consists of medium-sized smooth hypodermal oxypentacts. The autodermal pentact pinuli are relatively long (about 0·4 mm.), and bear four slim medium-sized basal rays, and a distal beset with somewhat long spines (Pl. XXXIII. fig 15).

The superior sieve-network is supported by reticulate strands of strongly developed, moderately long, smooth oxydiacts, which, as a rule, exhibit at the middle only two hemispherical or flatly apposed nodes. Between these, simple, strong, smooth oxytetracts occur here and there, and also pentacts with rays of a similar character. The autodermal pentact pinuli of this terminal sieve-plate are, for the most part, like the dermal, though in some regions longer (Pl. XXXIII. fig. 14).

Since the abundant amphidiscs of the external skin and those of the terminal sieve-membrane are exactly alike, I will describe them for both localities at once. Most striking is the largest form (about 0·2 mm. long), which exhibits a strongly developed axial rod, smooth with the exception of four cruciately disposed central protuberances, and with very gently arched terminal umbel rays, extending only over about one-third of a sphere, and provided with eight teeth. These short umbel rays are very broad, and terminate in a paddle or leaf-like point (Pl. XXXIII. fig. 9). Besides these, amphidiscs of medium size occur with irregularly toothed axial rods, and with terminal umbels, hemispherical or longer, with eight slender rays (Pl. XXXIII. fig. 11). Similar forms sometimes occur with longer and more divergent umbel rays (Pl. XXXIII. fig. 12). As in almost all species of *Hyalonema* numerous small many-rayed amphidiscs occur, as figured in Pl. XXXIII. fig. 13.

The marginalia exhibit a long toothed distal ray, a smooth proximal, and four cruciate hemispherical rudiments of the tangentials.

The spicules of the isolated basal tuft, which was found beside the body of the sponge, and most probably belongs to it, exhibit on their inferior extremity a very remarkable anchor-like structure. On the somewhat thickened terminal portion, four twisted, strongly developed rays project transversely in a circle, and then bend upwards at right angles along the equally long terminal portion. The latter portion is somewhat curved, and runs gradually to a point (Pl. XXXIII. fig. 10). On the prolongation of the axis there

is a small flat tubercle-like process, representing the abortive sixth ray. The long stalk exhibits, like the four anchor teeth, a distinct *axial canal.*

Subgenus 2. *Stylocalyx*, n. subgen. (Pl. XXXI.; Pl. XXXIV. figs. 1–11; Pls. XXXV., XXXVII., XXXVIII., XL., XLI.).

The superior aperture of the gastral cavity is not covered by a sieve-plate, but remains quite open. The gastral cavity is divided into four chambers by a central cone and four cruciate radial septa.

1. *Hyalonema* (*Stylocalyx*) *thomsoni*, Marshall (Pl. XXXIV. figs 1–11).

In his memoir on the Hexactinellidæ[1] W. Marshall describes a species of *Hyalonema* obtained by Wyville Thomson on the "Porcupine" Expedition to the north of the Shetland Islands, at a depth of 550 fathoms. This form measured 7 cm. in length, 3·5 being occupied by the body proper, and 3·5 by the basal tuft, and about 8 mm. in thickness. Through the kindness of O. Schmidt I have been able to examine this dried specimen. The body[2] has a spindle-like form, the upper end not being transversely truncated, but extending to a somewhat pointed apex, in the form of a projecting cone. The basal tuft is surrounded, just below the lower pointed end, by an encrustation of Palythoa, 3 mm. in length, and with four or five polypes. The number of slightly twisted basal spicules is estimated by Marshall at fifty or sixty. On some of them he observed a ridge with nail-like teeth, which was absent from others; the lower ends are all broken off. In the still partially preserved external dermal skeleton Marshall found regular "four-rayed" spicules which were mutually apposed by their limbs, and also several five-rayed forms. In the fir-tree forms situated on these spicules of the dermal network the spinose principal ray projects, according to Marshall, into the lumen of the rectangular dermal meshes in the plane of the skin, that is, lies tangentially. Besides these, amphidiscs occasionally occur, 0·03 to 0·08 mm. in length, and with six long, narrow, pointed anchor-teeth, as well as very small (0·008 mm. in length) double anchors. Within the body of *Hyalonema thomsoni*, Marshall describes four large cavities, into which large and small parenchymal passages open. On the wall of these cavities long curved uniaxial spicules occur, besides isolated smooth six-rayed forms and amphidiscs with small double anchors. In the parenchyma proper he found, besides the long uniaxial spicules, four-, five-, and six-rayed forms, and most frequently small hexacts.

In the covering membrane, which extends from the truncated superior and external margin to the conical knob projecting freely in the centre, Marshall observed four cleft-

[1] *Zeitschr. f. wiss. Zool.*, Suppl.-Bd. xxv. p. 225, 1875.

[2] *Loc. cit.*, Taf. xvii. fig. 84.

like openings which led into the four subjacent cavities. In this lid, and in the conical terminal knob, the same fir-tree-like amphidiscs occurred as in the external skin.

From my own examination of the specimen in Professor O. Schmidt's possession, which was originally investigated by Marshall, I am able to corroborate the essential results of Marshall's research, and I shall therefore only confine myself to extending and completing the latter.

The parenchyma proper in the above-described *Hyalonema* is supported by medium-sized, smooth, regular oxyhexacts, beside which numerous smooth, straight, or curved diacts occur, with or without central swellings. These have been already figured in detail by Marshall. Small oxyhexacts with straight roughened rays—and these only—occur in moderate abundance (Pl. XXXIV. fig. 4). In the dermal skeleton the familiar smooth hypodermal pentacts occur, as also autodermal pentact pinuli with somewhat long terminally toothed basal rays, and with a freely projecting pointed distal, about 0·24 mm. in length, and beset with long oblique curved spines (Pl. XXXIV. fig. 6). Roundish amphidiscs of various form and size, of which the largest have an average length of 0·2 mm., also occur. They are characterised by the possession of a flat, short, terminal umbel on either side, with six simple hook or claw-shaped, narrow rays, not terminally broadened. The moderately strong axial rod bears isolated hemispherical nodes, four of which, usually somewhat more strongly developed, are cruciately disposed in the centre (Pl. XXXIV. fig. 2). An amphidisc of this type, in process of formation, is figured in Pl. XXXIV. fig. 7. Besides these typical six-rayed large amphidiscs, others half as large occur, with long, campanulate, narrow, eight-rayed umbels, the slender rays of which almost meet, diverging somewhat laterally towards one another. The narrow axial rod has a central nodule (Pl. XXXIV. fig. 3). Still smaller forms whose umbels with eight or more rays are short and hemispherical (Pl. XXXIV. figs. 5, 8), occur abundantly. In the basal pad of the lower end of the body strongly developed spicules occur, variously provided with rays from six to two in number. These truncate rays are thickly studded with spines or teeth from the ends to within a varying distance of the centre (Pl. XXXIV. figs. 10, 11).

The tuft of spicules is composed solely of long spicules, which bear toothed ringed ridges. These are either broken off inferiorly, or continued into a club-shaped or hemispherical four-toothed anchor with four strong, backwardly bent, narrow, pointed teeth (Pl. XXXIV. fig. 9).

Among some Hexactinellids of the "Porcupine" Expedition which I obtained through the Challenger Office, I found a specimen with characters exactly corresponding to those above described. This was obtained from Station 47 of the "Porcupine" Expedition, from a depth of 542 fathoms. The extended spindle-shaped form had a total length of 4·5 cm. The body proper, which was about 5 mm. in thickness, occupied 3 cm.; and was continued superiorly into an apex, while the narrowed lower end bore a colony of three or four *Palythoa* polypes, embracing the basal tuft for 2 mm. The spicules both of

the parenchyma and of the basal tuft were exactly similar to those above described. The skin was unfortunately wholly absent, so that nothing further could be ascertained as to dermal skeleton.

A third specimen, which in my opinion belongs to this species, *Hyalonema thomsoni*, is deposited in the Berlin Zoological Museum. It is labelled as *Hyalonema lusitanicum*, Bocage (?), was collected by Wyville Thomson off the West Hebrides, and is numbered 405. This splendid specimen has a total length of 21 cm., and the body proper, which occupies 9 cm., has a maximum breadth of 3 cm. I have figured it in its natural size on Pl. XXXIV. fig. 1. The apical cone projects—2 cm. in length—from the centre of the truncated terminal surface, which exhibits four cruciately disposed radial septa and interjacent apertures, and resembles exactly the superior surface of the specimen figured by Marshall. Below the somewhat sharply angular projecting lateral margins of this smooth terminal surface, which is not covered by a dermal sieve-network, the body exhibits a slight annular constriction but curves outwards again below the middle, and is finally conically narrowed towards the lower end. Below the somewhat rounded off annular basal pad, there is an encrustation (6 cm. long) of Palythoa, and from this the basal tuft is prolonged downwards (Pl XXXIV. fig. 1).

In the parenchyma, besides medium-sized, smooth, regular oxyhexacts and numerous smooth, straight, or gently curved oxydiacts, with or without central nodes or tubercles, a large number of small oxyhexacts with straight, somewhat roughened rays occur, similar to those which we have already described and figured in the smaller specimens (Pl. XXXIV. fig. 4).

The dermal skeleton exhibits the same smooth hypodermal oxypentacts and somewhat long, narrow pinuli, with moderately long, slightly spinose, basal rays, as we have already described in the smaller specimens. The amphidiscs also essentially agree in size and form with those above described and figured (Pl. XXXIV. figs. 2, 3, 5, 7, 8,), and differ only in this, that the largest amphidiscs with short, narrow umbel rays have, as a rule, not *six* but *eight* rays. The substantial toothed spicules of the basal pad and the long spicules of the root-processes essentially resemble those of the above forms; occasional, slight, and inconstant differences seem to me to be simply individual, conditioned by the large size, and in no way of specific importance.

The superior terminal surface is in this specimen much better preserved than in the smaller forms, so that the essential agreement between the covering membrane and the external skin is demonstrable, except that the autodermal pentact pinuli are somewhat narrower and longer than in the former. The same enveloping layer extends for some distance into the system of efferent tubes.

Near the basal pad numerous more or less long diacts occur in the parenchyma, and do not run out at their ends into smooth points, but are somewhat thickened and spinose before finally terminating in conical points. At the middle point of

these diacts with spinose terminal portions four cruciate hemispherical tubercles usually occur.

This species, *Hyalonema thomsoni*, differs from *Hyalonema lusitanicum*, Bocage, not only in general form and in the long projecting cone, but more especially in the large amphidiscs with short narrow umbel rays, and in the absence of small oxyhexacts with curved rays.

Though I have no hesitation in including the three forms described above within the one species, *Hyalonema thomsoni*, Marshall, I am in doubt as to a specimen of *Hyalonema* dredged near the Azores (Station 73, lat. 38° 3′ N., long. 31° 14′ W.), at a depth of 1000 fathoms, from a Pteropod ooze ground. This fragment, which has a total length of only 3 cm., represents the lateral portion (about one-third) of a pear-shaped body, about 8 mm. in breadth at the upper end, while the inferior portion narrowed to 2 mm. projects as a broken tuft of few spicules. The superior extremity of the body is not preserved.

The parenchymal spicules consist of smooth oxydiacts of various lengths, with or without central tubercles, and of moderately large smooth oxyhexacts and smaller forms with straight somewhat roughened rays,—all exactly agreeing with those already described in *Hyalonema thomsoni*. The hypodermal smooth oxypentacts and the somewhat slim autodermal pinuli of the skin do also not differ essentially from those of *Hyalonema thomsoni*, and the same may be said of the substantial spicules of the basal pad (Pl. XXXIV. figs. 15, 17), or of the long spicules of the root-tuft, distinguished by their four-toothed terminal anchors (Pl. XXXIV. fig. 16), which exhibit an axial cross.

Only the amphidiscs, still discoverable in the small and isolated remnants of the skin, are somewhat divergent from those of the specimens of *Hyalonema thomsoni*, in the apparent absence of the large form bearing short hemispherical terminal umbels with six or eight narrow hook-shaped umbel rays, and in such slight differences in the form of the small amphidiscs, as may be discovered by inspecting Pl. XXXIV. figs. 12, 13, 14. Since the apparent absence of the large amphidiscs may very probably be referred to the incompleteness of the specimen in which the skin was almost gone, and since besides the small divergent amphidiscs exactly congruent forms also occur, there seems no reason to erect a separate species for this fragment, and I therefore content myself with designating it *Hyalonema thomsoni*, var. *exiguum*.

2. *Hyalonema* (*Stylocalyx*) *apertum*, n. sp. (Pls. XXXVII., XXXVIII.).

In the Sagami Bay, west of Yokohama in Japan (Station 232, lat. 35° 11′ N., long 139° 28′ E.), from a depth of 345 fathoms and a green mud bottom, several specimens of *Hyalonema* were dredged. In some of these the body is still well preserved, but in most only the basal tuft and the *Palythoa* incrustation remain. The body of the

sponge is cup-shaped, more or less curved outwards laterally, and truncated transversely or obliquely above. The superior terminal surface is sometimes almost flat, usually, however, markedly concave, and always provided with a sharp-angled projecting marginal fringe, and with a central more or less markedly projecting cone. From the inferior lateral portion of this central cone four radial longitudinal plates extend as septa through the gastral cavity, broadening out laterally to unite with the thick body-wall. By these four cruciately disposed septa, four cavities opening widely on the upper terminal surface are enclosed, and these are continued laterally and inferiorly into the tree-like branched system of efferent canals. The fine terminal canals extend to within a short distance of the external skin, and there end blindly in those diverticula of the membrana reticularis which are characteristic of the Hyalonematidæ (Pl. XXXVII. figs. 1–3; Pl. XXXVIII. fig. 1). Close below the inconspicuous annular basal pad, surrounding the upper portion of the long much twisted root-tuft, there is an incrustation of *Palythoa*, which embraces in some forms only a small portion, and in others two-thirds or more of the long tuft.

The total length of the sponge varies between 18 and 50 cm., of which the body itself occupies, on an average, from 5 to 8 cm. The maximum diameter sometimes occurs just below the upper end, sometimes about the middle, and varies from 3 to 6 cm. The average thickness of the basal tuft, just below the lower end of the body, is 3 to 4 mm.; further down, however, it becomes greater until the brush-like divergence of the spicules begins. Apart from some circular apertures from 1 to 4 mm. in diameter, the superior convex surface of the body and the whole surface of the freely projecting conus are seen to be fairly smooth. On the other hand, the whole lateral surface distinctly exhibits, even to the naked eye, the rectangular lattice-work of the dermal membrane (Pl. XXXVII. fig. 3).

The parenchyma contains a few medium-sized superficially smooth oxyhexacts, and numerous oxydiacts, disposed in strands or lying singly, with or without central swellings or with two or four cruciate nodes (Pl. XXXVIII. fig. 3). The small oxyhexacts which occur in great abundance are all rough, and almost thorny, and have more or less markedly curved rays (Pl. XXXVIII. fig. 5). Isolated very small but strongly developed oxyhexacts, with distally directed teeth (Pl. XXXVIII. fig. 4), occasionally occur.

The dermal skeleton, which appears on surface view as a conspicuous rectangular lattice-work (Pl. XXXVIII. fig. 2), consists of simple smooth medium-sized hypodermal oxypentacts, and of abundant autodermal pentact pinuli, about 0·2 mm in length, with strongly developed short-toothed basal rays, and somewhat strongly developed distal ray, with short obliquely inserted, spines (Pl. XXXVIII. fig 10), and finally of irregularly scattered, large, medium-sized, and small amphidiscs. The former, measuring from 0·15 to 0·17 mm. in length, have a strong knotted axial rod, and broad umbels with eight paddle-shaped rays (Pl. XXXVIII. fig. 7); the middle-sized forms have from ten to twelve long narrow umbel rays (Pl. XXXVIII. fig. 6); while the very abundant small forms bear

hemispherical umbels, with many (usually twelve) rays, and thin axial rods, either smooth or with median nodes (Pl. XXXVIII. figs. 8, 9).

The gastral skeleton exhibits smooth hypogastral pentacts similar to those occurring in the skin, the same form of pinuli as autogastralia, and similar or somewhat smaller amphidiscs (Pl. XXXVIII. figs. 1, 12). While the smooth pentacts and the amphidiscs are confined to the gastral membrane and to the lining of the largest efferent passages, the pinuli have a somewhat wider distribution, and, becoming scarcer as the four basal rays are more prolonged, are continued into the efferent system of canals even to the fine terminal branches, where they finally entirely cease (Pl. XXXVIII. fig. 1).

The projecting fringe of spicules on the external sharp margin of the oscular region consists of marginal oxydiacts at least 0·5 mm. in length, with long distal ray bearing minute obliquely disposed spines. The proximal ray, which is about a third shorter, bears very small backwardly directed teeth. At the boundary between the two rays four cruciately disposed hemispherical or somewhat larger knobs protrude (Pl. XXXVIII. fig. 11).

In the lower narrowed end of the body, and especially in the basal pad, compact six to two-rayed spicules with blunt, toothed, or spinose ends occur, like those in the same position in most species of *Hyalonema*. The spicules of the basal tuft vary greatly in length, and resemble in structure those of *Hyalonema sieboldii*, to which *Hyalonema apertum* presents a close resemblance in the general structure of its spicules. While the upper portion of these long-stalked anchors is quite smooth, the lower bears oblique rows of barbs on projecting ridges, and, on the very end, borne on a smooth narrow neck, a hemispherical or helmet-shaped terminal knob with four to eight shovel-shaped marginal anchor teeth, which are directed obliquely upwards and outwards. The intersection of the axial canals in these long anchor spicules always lies in the lower swollen end, in the head of the anchor.

In a rich collection of Japanese forms brought home by Dr. Hilgendorf, and deposited in the Berlin Zoological Museum, are several dried and well-preserved spirit specimens of *Hyalonema apertum*. On closer examination of these I found two small dried specimens of this species, which had been temporarily designated by Professor W. Marshall as *Hyalonema affine*, Marshall. I refer on this point to the brief description which Marshall gives, in his researches on Hexactinellids (1875), of *Hyalonema affine*, a species which he had erected for a form which had been already examined by Max Schultze and noted by him as "B" and "C."

The diagnosis which Marshall gives (*loc. cit.*, p. 234) is as follows:—"*Hyalonema affine*, if not, as I believe, a distinct species, is at least a specially well defined variety of *Hyalonema sieboldii*. The tuft is 47 cm. long and only 8 mm. broad; the sponge body proper has a length of 9 cm. Other specimens exhibit, with an axial strand of about the same length, though of greater breadth, a larger sponge-body, which measures for instance

in the specimen figured by Max Schultze on Taf. i., 13 cm., while the root-tuft is 48 cm. long and 1·5 cm. broad. I wish, however, to lay special emphasis on this, that in *Hyalonema affine* the dermal skeleton (partly rubbed off however, though not to such an extent as Max Schultze describes) exhibits peculiar characteristics. From the lower end of the sponge body, from the position where the axial tuft enters, numerous longitudinal strands, 0·5 mm. in breadth, arise, dividing repeatedly and anastomosing with one another, becoming gradually narrower in so doing, and I did not observe these longitudinal strands in any other specimen of *Hyalonema*, although I examined a considerable number in various states of preservation. The strands are composed of uniaxial, decidedly long (8 cm.) pliable spicules which frequently intersect. At the point of intersection there is a tolerably constant occurrence of a spicule with dimensions which neither I nor Max Schultze have ever found in *Hyalonema sieboldii*, namely, with an axial length of fully 3 mm. The intersecting bundles lie in the direction of the axes. Between these strands there is a further dermal skeleton, but this in no way differed from that of the other specimens. Similarly the afferent apertures, and indeed the rest of the sponge-tissue, agreed both in macro- and microscopic characters with *Hyalonema sieboldii*, though the apertures were not so abundantly present. It seemed to me, however, that the great differences in size, and especially the peculiar character of the dermal skeleton, justified the erection of a new species, closely related to *Hyalonema sieboldii*."

According to this description, which was of course based on a single, dry, and probably not very well preserved specimen, it seems to me possible that the form above described as *Hyalonema apertum* may be identical with Marshall's *Hyalonema affine*, and I have indeed hesitated long whether I should adopt the older designation. There is, however, in Marshall's diagnosis no mention of some of the peculiarities which are typical and characteristic of *Hyalonema apertum*, especially the complete absence of the terminal sieve membrane, while the character especially emphasised by Marshall, namely, the presence of intersecting bundles of long uniaxial spicules below the skin of the dried specimen, occurs also in various other species of *Hyalonema* (though not in *Hyalonema sieboldii*, owing to the presence of countless commensal polypes), so that no certain and exclusive character seems to remain to *Hyalonema affine*. The dimensions of the body or of the basal tuft cannot be regarded as in any way determinative.

Since, then, it is not probable that *Hyalonema affine*, Marshall, is identical with my *Hyalonema apertum*, I prefer to retain for the time the latter title.

3. *Hyalonema* (*Stylocalyx*) *depressum*, n. sp. (Pls. XXXV., XXXVI.).

In the Mid-North Pacific, north of the Mellish Islands (Station 246, lat. 36° 10′ N., long. 178° 0′ E.), from a depth of 2050 fathoms and a Globigerina ooze ground, several specimens of *Hyalonema* were dredged, which in general form differ markedly from the

above-described species, in exhibiting a body broader than long (Pl. XXXV. figs. 1, 2). The breadth bore to the length an average proportion of 2 : 1, so that the whole body of the sponge appeared as compressed from above downwards. The lateral margin is, however, never sharp. From the middle of the superior gently convex surface, an irregularly roundish, narrow and sharp, oscular fringe projects, consisting of a circle of parallel rod-like spicules (Pl. XXXV. figs. 1, 2). Through the roundish oscular opening, one sees the bluntly rounded conus centralis projecting to the level of the aperture, while from the sides of the former four cruciately disposed main septa extend laterally and inferiorly. Between these cross septa the ramified efferent canals penetrate into the parenchyma (Pl. XXXV. fig. 2). The surface of the under side is but rarely simply convex, as in Pl. XXXV. fig. 1; it usually appears somewhat flattened or even pressed slightly inwards. The portion from which the tuft of basal fibres springs is however usually somewhat protruded. The spicules of the basal tuft are rather strongly developed, in large specimens almost attaining the thickness of pins. They are, however, not preserved throughout their whole length. Sometimes the bunch of spicules attains the thickness of one's little finger (Pl. XXXV. figs. 1, 2). The largest specimen measured 12 cm. in breadth, and about 6 cm. in height; the smallest was 5 cm. broad, and 3 cm. high. Ten perfect specimens and some fragments were procured.

The parenchyma of the sponge is supported by the usual medium-sized smooth oxyhexacts, and by numerous smooth, straight, oxydiacts with tolerably large central nodes. More rarely a terminal swelling occurs (Pl. XXXVI. fig. 2). Between the above forms lie a great number of small rough oxyhexacts, with straight or curved rays (Pl. XXXVI. figs. 9, 10; Pl. XXXV. figs. 9, 10).

In the dermal skeleton somewhat large, smooth hypodermal oxypentacts occur, in which the four tangential rays are *not* disposed at right angles to the radial proximal in a single plane, but are bent somewhat inwards (Pl. XXXVI. fig. 8). The proximal ray is generally three or more times longer than the tangentials. Externally the skin is thickly covered with numerous autodermal pentact pinuli, with four somewhat short and thick basal rays bearing small firm tubercles, while the moderately long, strong distal exhibits somewhat strong lateral spines directed upwards (Pl. XXXV. fig. 7). The largest of the dermal amphidiscs are about 0·2 mm. in length, and occur somewhat sparsely; they bear a very narrow, smooth, or slightly roughened axial rod, with four or eight lateral teeth. In some cases these middle teeth are curved forward towards the distal umbel of rays (Pl. XXXVI. fig. 3). The terminal umbels are somewhat long and bell-shaped, and consist of eight to twelve lancet-shaped, but usually quite narrow rays (Pl. XXXV. fig. 4). Besides these, medium-sized amphidiscs of similar form occasionally occur, and likewise small forms with many-rayed hemispherical terminal umbels (Pl. XXXVI. fig. 6).

Of similar structure is the gastral skeleton on the free surface of the central cone, on the main septa, and in the large gastral cavities, while it gradually assumes a different

character in the tubular efferent canals, especially through the degeneration and final disappearance of the supporting hypocanalicular pentacts, as also through the shortening of the autocanalicular pentact pinuli, which further exhibit a less thickly spinose free ray and longer roughened basal rays. Lastly, in the finer canals the pinuli gradually become further and further distant from one another, until just before the diverticula of the membrana reticularis only isolated very delicate pinuli occur (Pl. XXXVI. fig. 1). Numerous amphidiscs lie in the gastral-canalicular membrane, but do not penetrate as far as the layer of chambers. The large form of amphidiscs (Pl. XXXVI. fig. 3) is here altogether absent, but the medium-sized, and especially the smaller are often present in great abundance.

The marginalia form a closed ring on the free sharp edge of the oscular aperture. They have the form of moderately long oxydiacts with perfectly smooth proximal, and somewhat thickly spinose distal rays. On the boundary between the two rays, two opposite, or rarely four cruciate tubercles or bosses almost always project. These are usually hemispherical or somewhat longer than broad, or else completely rounded off.

The basal pad contains the familiar firm spicules with six to two rays, the ends of which are beset with spines, while the inner portion remains smooth (Pl. XXXV. fig. 8). The strongly developed spicules of the basal tuft, almost as thick as pins, are in part smooth, and in part studded with numerous nail-like barbs, which are not inserted on annular or spiral cross ridges, but are disposed in isolated fashion in indistinct and irregularly developed spiral rows (Pl. XXXVI. fig. 7). Viewed from the surface, the freely projecting points of the teeth appear to be marked off by a line of basal tubercles. Such a bounding line does not really exist above, as may be readily seen when viewed in profile, but is merely the optical expression of the upper margin of the origin of the barbs on the surface of the spicule. Towards the lower end the long spicules become markedly thinner, the lateral barbs diverge further from one another, and the spicule ends below in a peculiar hemispherical anchor structure with four double hooks cruciately disposed (Pl. XXXVI. fig. 11), or in a hemispherical terminal knob from which four minute simple cruciate pointed barbs project backwards, as in the anchors of *Hyalonema thomsoni*, var. *exiguum* (Pl. XXXIV. fig. 16).

Several forms of *Hyalonema*, differing only in subordinate characters from that above described, and wholly agreeing with it both in general organisation and in the structure of the spicules, and therefore undoubtedly belonging to the same species, were dredged in the Mid-Pacific (Station 271, lat. 0° 33′ S., long. 151° 34′ W.) from a similar depth of 2425 fathoms and from a Globigerina ooze bottom. There are two perfect specimens, destitute only of the freely projecting portion of the basal tuft, and also the fragment of a third form, all procured at the same locality. All the three seem somewhat smaller than the above, and exhibit either a conical form with an inferior point, or a flat cake-like shape. The breadth varies from 5 to 6 cm; the height from 3 to 4, and in the latter form

measures only 2 cm. In other respects the form and structure are not essentially different. The somewhat brighter colour is rather striking, being in these three forms light greenish-yellow, while those from Station 246 were dark dull greenish-brown. The section in Pl. XXXVI. fig. 1, is a diagrammatic representation of a longitudinal section through the external marginal portion of one of the specimens from Station 271.

4. *Hyalonema* (*Stylocalyx*) *clavigerum*, n. sp. (Pl. XLI.).

In the neighbourhood of the Penguin Islands (Station 147, lat. 46° 16′ S., long. 48° 27′ E.), from a depth of 1600 fathoms, and from a Diatom ooze ground, a fragment of a *Hyalonema* was dredged, which is represented in Pl. XLI. fig. 1. The fragment represents about one-eighth of the whole body, and is without any trace of the basal tuft, but still exhibits a portion of the oscular margin and one of the radial septa. The consistence of this sponge fragment, which is about 5 cm. long, and represents a probably truncated oval body, is not so great as that of *Hyalonema globus*. The whole external surface distinctly exhibits a well-developed rectangular dermal framework.

The parenchymal skeleton consists again of somewhat large smooth and radially disposed oxyhexacts, and of simple oxydiacts which are either smooth, or have a median swelling or four projecting median knobs. Between these, thin forms equipped at both ends with delicate barbs (Pl. XLI. fig. 6) occasionally occur, like those found abundantly in the parenchyma of *Hyalonema globus* (Pl. XL. fig. 5).

Besides these, minute delicate oxyhexacts occur in some abundance, exhibiting fine straight pointed rays, on which a gentle curvature may, here and there, be detected (Pl. XLI. fig. 7).

Those oxyhexasters which are represented in large numbers in the diagrammatic section of Pl. XLI. fig. 2, and under high power in Pl. XLI. fig. 5, do not really belong to this sponge, nor indeed to the genus *Hyalonema*, but are forms which have been accidentally imported.

The dermal skeleton is mainly composed of somewhat large smooth hypodermal oxypentacts, with oblique, inwardly directed tangential rays. On the outer surface numerous autodermal pentact pinuli occur, with rather long, smooth and pointed, basal tangential rays, while the relatively short distal ray bears, as in *Hyalonema globus*, long, fine, upwardly bent lateral spines, and a knob-like external terminal portion with thick, somewhat pointed axial end, and so has a tufted appearance (Pl. XLI. fig. 4).

The somewhat large amphidiscs which are irregularly scattered in radial disposition within the external skin, exhibit a firm smooth axial rod with several (four or eight) radially projecting tubercles in the centre. The bell-shaped terminal umbels are rather broad, and measure about one-fourth of the total length. They consist of eight broad shovel-shaped rays with lancet-like pointed ends (Pl. XLI. fig. 9). There is a much sparser

occurrence of rather small elongated forms, with narrow umbel-rays (Pl. XLI. fig. 10). Very frequent, on the other hand, is the occurrence of the familiar small amphidiscs with ten- or twelve-rayed, short, hemispherical umbels (Pl. XLI. fig. 11).

In the gastral membrane and in the lining of the larger efferent canals the hypogastral oxypentacts are absent, but strands of oxydiacts of various thickness, with or without central thickening and projecting nodes occur abundantly. The autogastral pentact pinuli are strikingly distant from one another, and bear long, pointed, somewhat spinose basal rays, and a rather long spindle-shaped, thickened proximal with short, almost scale-like teeth (Pl. XLI. figs. 2, 8). Small amphidiscs with twelve- or more rayed, short, hemispherical umbels occur abundantly in the gastral membrane. The cuff-like limiting fringe round the sharply defined oscular margin consists of oxydiacts, almost 1 mm. long, in which the proximal ray is quite smooth and simple, and uniformly narrowed into a sharp point, while the free distal ray, close above the smooth inner portion, is beset in fir-tree-like fashion with scale-like or pointed spines, projecting obliquely outwards, and also exhibits a spindle-shaped thickening (Pl. XLI. fig. 3).

5. *Hyalonema* (*Stylocalyx*) *globus*, n. sp. (Pl. XL.).

Near the Banda Islands, in the Malay Archipelago (Station 194A, lat. 4° 31′ S., long. 129° 57′ 20″ E.), from a depth of 360 fathoms and volcanic mud ground, a specimen of *Hyalonema* was dredged which differed in some points from the species hitherto described. The body which is almost globular measures 23 mm. in length and 22 mm. in breadth. On the superior pole there is a round oscular aperture, 4 mm. in diameter, with a sharp tangentially directed margin bounded by a thin fringe of spicules (Pl. XL. fig. 1). Through this terminal opening the gastral cavity can be seen with the somewhat pointed conus rising from below, and with four cruciately disposed radial septa, extending from the lower portion of the conus to the margin, towards which they become broader. The lower pole of the spherical body bears an apparently much damaged basal tuft. The scanty spicules do not exceed 0·2 mm in thickness (Pl. XL. fig. 1). The whole uniformly curved external surface of the body is covered with a dermal lattice-work, the distinct meshes of which are approximately or perfectly square, and formed of strands which are arranged like the lines of longitude and latitude on a globe.

The parenchyma is supported by strongly developed smooth medium-sized oxyhexacts, and by oxydiacts of variable length and thickness disposed in strands. Besides these smooth oxydiacts, forms occur in some abundance, in which not only both ends, but the central portion, and rarely the whole spicule, are more or less thickly covered with centrally directed barbs. Four cruciately disposed projecting nodes occur in the centre, and these are sometimes continued into curved hooks (Pl. XL. fig. 5). The parenchyma further contains a considerable number of very slim, smooth oxyhexacts of variable size,

but usually about 0·2 mm. in diameter (Pl. XL. fig. 10). The spicules represented on Pl. XL. figs. 3, 11, 13, also occur here and there in the parenchyma, but do not really belong to this species, being extrinsic importations from other forms, perhaps from a *Crateromorpha*.

The basis of the dermal skeleton consists of strongly developed smooth oxypentacts. The apposition of the tangential rays of the latter forms the square-meshed lattice-work, which can be recognised even with the unaided eye (Pl. XL. fig. 2). This gives this sponge a greater compactness than is possessed by any other species of *Hyalonema*. The radially directed proximal ray is longer than the tangentials. Adjacent to the latter lie strands of smooth oxydiacts with central swelling or nodes. The autodermal pentact pinuli exhibit comparatively long, straight, spinose basal rays, about 0·05 mm. in length, while the somewhat short (about 0·1 mm.) projecting distal is characterised by the long lateral spines, directed upwards and outwards, which begin at some distance from the base, are somewhat distantly inserted in the middle portion, become more closely apposed in the upper part of the ray, and finally form a kind of bud, in the middle of which lies the end of the ray, in nowise thin or gradually pointed, but rather thick and ending in a conical point (Pl. XL. fig. 16).

The abundant and characteristic amphidisc in the skin is a large, strongly developed form, 0·4 mm. in length, in which the thick smooth axial rod is centrally beset by eight slim tubercles or bosses. The somewhat broad, but not very long terminal umbels are not uniformly hemispherically arched, but are at their outer end slightly truncated. The eight umbel rays with broad, blade-like, longitudinal bases, have a broad paddle-like form and a rounded end (Pl. XL. fig. 7).

Besides these, there is a frequent occurrence of those small amphidiscs with hemispherical, twelve- or more rayed terminal umbels, and with slim delicate axial rod, which occur in the skin of all species of *Hyalonema* (Pl. XL. fig. 15). In the gastral membrane, however, the hypogastral pentacts are either wholly absent, or of very sparse occurrence, while the strongly developed smooth oxydiacts and the associated pentact autogastral pinuli are very abundant. The latter exhibit rather long slightly spinose basals, and a free fir-tree-like ray, which runs out into a thin terminal point and bears short curved lateral spines. I did not find any large amphidiscs in the gastral membrane, but the small forms occur in great abundance.

The marginal fringe of the superior oscular aperture is formed of oxydiacts which attain a length of only 1 mm. The freely projecting distal ray is beset with hook-shaped externally curved spines, while the proximal bears only small pointed tubercles. At the boundary between the two, on the thickest portion of the spicule, four cruciately disposed hemispherical bosses project (Pl. XL. fig. 6).

In the basal pad numerous strong spicules with six to two rays occur, in which the blunt ends are thickly beset with spines. It may be frequently observed, especially in

the numerous tetracts, that the rays are somewhat curved, even in the cross plane (Pl. XL. fig. 12). The spicules of the basal tuft, which vary greatly in size, are smooth superiorly, but inferiorly beset with isolated barbs, while the helmet-shaped thickened lower end bears four long cruciate, flat or roundish, anchor teeth of variable length, directed upwards and outwards (Pl. XL. figs. 8, 9).

6. *Hyalonema* (*Stylocalyx*) *elegans*, n. sp. (Pl. XXXI. figs. 1–7).

In the Mid Pacific, to the south-east of the Christina Islands (Station 271, lat. 0° 33′ S., long. 151° 34′ W.), from a depth of 2425 fathoms and a Globigerina ooze bottom, an extremely delicate and soft *Hyalonema* was trawled. The compressed roundish inferiorly pointed body has a thickness of about 2 cm., and bears a basal tuft of a few projecting spicules which measure 12 to 14 cm. in length (Pl. XXXI. fig. 1). At the upper end of the body a central cone slightly projects, and from it four cruciately disposed radial plates extend, dividing the central cavity into four divisions. The superior openings of these cavities are seen as irregular roundish gaps on the upper surface. It is improbable that a terminal sieve plate extended over these apertures; no trace of such a structure persists. On the upper half of the body, indeed, the whole outer skin seemed to have been rubbed away, while traces of the same are still recognisable on the lower somewhat bulging conical portion.

The loose parenchyma contains not only simple smooth medium-sized oxyhexacts, and numerous smooth (or rarely terminally roughened) (Pl. XXXI. fig. 3) oxydiacts of medium size and inconsiderable length, but also a great number of small smooth oxyhexacts with curved rays.

The dermal skeleton (Pl. XXXI. fig. 2) consists of somewhat strongly developed, smooth oxypentacts, on which numerous autodermal pentact pinuli are apposed. The latter exhibit four moderately long, terminally slightly toothed basal rays, and a more or less spinose distal (Pl. XXXI. fig. 4) which may attain a length of 0·5 mm. Besides these, numerous medium sized eight-rayed amphidiscs occur, bearing on their axial rod several somewhat irregularly distributed boss-like, projecting, lateral tubercles, and exhibiting straight, bell-shaped terminal umbels which are so long that their flat lancet-shaped rays almost meet one another (Pl. XXXI. fig. 6). There are also numerous minute amphidiscs with slightly arched short umbels, 0·02 to 0·04 mm. in length (Pl. XXXI. figs. 5, 7). Isolated large broad amphidiscs also occur, but I am doubtful whether they really belong to this species. From their scarcity and irregular disposition it seems probable that they owe their origin to one of the other species of *Hyalonema* which lay in the same glass and which contain these broad amphidiscs in abundance. The basal tuft exhibits numerous firm spicules with six to two rays, which are straight and terminally beset with strong teeth, or else truncated or rounded.

The long spicules of the tuft are quite smooth and are all broken at their lower end.

7. *Hyalonema* (*Stylocalyx*) *tenerum*, n. sp. (Pl. XXXI. figs. 8–20).

In the South Pacific (Station 289, lat. 39° 41′ S., long. 131° 23′ W.), from a depth of 2550 fathoms and a red clay bottom, a delicate and very loose *Hyalonema* was dredged, which exhibited a pear-shaped body 4 cm. in length, and 25 cm. in maximum breadth. In the middle of the upper, very injured extremity a pointed cone projects, from the sides of which four cruciately disposed longitudinal septa extend to the side wall, separating the central cavity into four chambers. From the lower, somewhat pointed end, a narrow basal tuft projects for about 16 cm. It is composed of about fifty spicules which are wound spirally together, and which exhibit only at the very extremity a somewhat straighter, and more separate course. The general form of the body, as represented on Pl. XXXI. fig. 8, has obviously been very considerably altered by damage done to the upper half. The latter appears to have been much rubbed away, and the superior external margin of the upper terminal surface has been wholly destroyed.

The spicules of the parenchyma consist for the most part of medium-sized smooth oxydiacts, beside which there occasionally occur, especially near the outer wall, smooth knobbed or terminally toothed diacts, and sometimes even monacts (Pl. XXXI. fig. 10). Besides these long rod-like spicules, medium-sized straight oxyhexacts occur in considerable abundance in the parenchyma, while small oxyhexacts with curved smooth rays (Pl XXXI. figs. 9 and 17) are very prevalent, and exactly resemble the small curved oxyhexacts of *Hyalonema elegans.*

The dermal skeleton contains the often mentioned, moderately large, smooth hypodermal oxypentacts without a trace of a (sixth) distal ray. Numerous large autodermal pentact pinuli also occur—with four rather long basal tangential rays—strongly developed and with toothed pointed ends, while the extraordinary long (1·6 mm. and more), radially projecting distal is beset with short teeth except in the smooth basal portion (Pl. XXXI. fig. 11).

The dermal membrane contains numerous short broad amphidiscs, which exhibit a perfectly smooth, strongly developed axis-rod, bearing hemispherically arched, broad, terminal umbels with smooth, paddle-shaped rays almost meeting in the middle, and occurring in variable number from eight to twelve, but usually ten or eleven (Pl. XXXI. figs. 12, 13, 20). The interior side of the smooth, terminally rounded, paddle-shaped umbel rays exhibits an inward projecting median ridge, ending in an elevation before the extremity of the ray. In Pl. XXXI. fig. 18 one of these abnormal spicules is represented, with four rays, as occasionally occurs in addition to the form with six. Besides these large almost globular amphidiscs, in which the opposite paddle-shaped umbel

rays are frequently not exactly opposed, but more or less regularly alternating (Pl. XXXI. fig. 12), more elongated medium-sized forms also occur, which are sharply distinguished from the above, by the fact that the umbel is not hemispherical but terminally truncate, and furnished with more straightly stretched, obliquely inserted, terminal rays (Pl. XXXI. fig. 14). A somewhat smaller form also occurs, in which the umbel rays are not broadened out in paddle-like fashion, but exhibit a narrow point, and in which the axial rod is more or less thickly beset with lateral spines. Finally, the familiar small amphidiscs, with narrow, smooth, axial rods and hemispherical many-rayed (sixteen to twenty) umbels (Pl. XXXI. fig. 16), also occur in tolerable abundance, varying in the different regions of the body. In the lowest terminal portion of the body, in the so-called basal pad, strongly developed spicules with six to two rays occur as in all species of *Hyalonema*. The rounded or truncate ends of the rays are beset with conical teeth or spines, extending to a greater or less distance interiorly (Pl. XXXI. fig. 15).

The long spicules of the basal tuft exhibit spiral or annular, obliquely projecting ridges and rows of teeth, which are inserted on the projecting edge of the ridges.

There now follow those species of *Hyalonema*, the upper end of which was not sufficiently preserved for deciding the question, whether there is a sieve-plate or not.

1. *Hyalonema lusitanicum*, Barboza du Bocage (Pl. XXVIII. figs. 12–17; Pl. XXXIX. figs. 16–18).

The specimen which Barboza du Bocage obtained in the neighbourhood of Setubal in Portugal, and which he described and figured[1] under the title *Hyalonema lusitanicum*, consisted of a spirally twisted tuft of spicules, the narrower end of which was for a length of 16 cm. and also at the terminal point, completely covered by a continuous layer of *Palythoa*, while in the longer free portion the spicules diverged in bushy tufted fashion. Neither on this specimen, nor on others which Bocage afterwards obtained from the same locality, could any portion of sponge-body be detected. The following diagnosis was given :—"Hyalonema polypario elongato, fibris setaceis hyalinis spiraliter tortis, corio polypigero ad apicem usque ad $\frac{2}{5}$ longitudinis totius involutis; polypis dilatatis, ellipticis, valde aggregatis, parum elevatis, per series longitudinales ac spirales regulariter digestis." Barboza must afterwards have found more perfect forms in which the sponge-body was preserved, for I found in the British Museum in South Kensington, London, a spirit specimen with the label *Hyalonema lusitanicum*, Barboza du Bocage, and described as a gift from the discoverer. The specimen was 56 cm. in length, and exhibited on the much damaged upper end a projecting tuft.

[1] *Proc. Zool. Soc. Lond.*, 1864, p. 265.

I was able to procure several small fragments of this original specimen, and the results of my investigation seem to warrant me in amplifying the specific diagnosis of *Hyalonema lusitanicum*. From my own notes and from some subsequent observations which Mr. Ridley was kind enough to make for me, the length of the much damaged body is 12 cm., the breadth only 2·7. The much twisted basal tuft of spicules has a breadth of 15 mm. The *Palythoa* crust is *not* present having been probably separated off.

In the absence of a marginal fringe and of the probably originally present terminal sieve-net, it is impossible to determine whether the tuft of spicules, projecting for about 1 cm. on the upper end, and doubtless representing a damaged conus, really projected in the intact form.

Another form in the British Museum, which is said to have been brought from Porto Rico, exhibits a body transversely truncated above, with a well-developed terminal sieve-net, and with an indication of the conus centralis. The basal tuft here attains a length of 26 cm. and is covered with the *Palythoa* crust. Whether this second specimen really belongs to Bocage's *Hyalonema lusitanicum*, I am not able to determine, since I have not been able to analyse the structure of its component spicules.

The following description of the skeleton refers only to the first mentioned original specimen of *Hyalonema lusitanicum*, Bocage.

The supporting spicules of the parenchyma consist for the most part of diacts of variable size and thickness. These are somewhat pointed at either end, and usually exhibit a simple, spindle-shaped, perfectly smooth course, or occasionally bear a single tubercle, or there may be four or two, projecting from the middle point. They are generally somewhat curved, though frequently perfectly straight. Between these diacts medium-sized oxyhexacts occur, though on the whole not very abundantly. They exhibit six simple, somewhat pointed, straight and smooth rays, which are generally of equal length. Sometimes, however, four rays cruciately disposed are of uniform length, while the other two lying in the third axis, that is to say, radially disposed, are somewhat longer. I also found isolated monacts with one end thickened into a knob or rounded off like a button, while the other ended in a point. Scattered through the whole parenchyma in relative abundance there are small, smooth or slightly roughened oxyhexacts, with rays which are seldom perfectly straight (Pl. XXVIII. fig. 16), but usually bent in the familiar fashion, so that three approach each other, and the three antipodals likewise (Pl. XXVIII. fig. 15).

The middle-sized hypodermal oxypentacts which serve to support the skin are quite smooth, their rays run terminally to a somewhat marked point. The autodermal pentact pinuli, which are usually inserted on the latter, bear four short, strongly developed, tangential basal rays, with blunt, slightly toothed ends, and a strong distal, about 0·3 mm. in length, which has an almost bushy appearance due to the long lateral processes (Pl. XXVIII. fig. 17). The majority of the numerous, radially disposed, dermal amphidiscs have a

length of 0·1 mm., a long, narrow, axial rod with central teeth, and at each end, a narrow bell-shaped umbel, occupying about a third of the total length, and provided with eight rays, which have no great breadth, and which have terminally a rather straight course (Pl. XXVIII. fig. 13). More rarely larger amphidiscs occur, of similar form, but with a length of 0·2 mm., and a proportionate breadth (Pl. XXVIII. fig. 14). Besides these numerous small amphidiscs occur from 0·03 to 0·02 mm. in length, exhibiting the same form as the above, but lying tangentially in the dermal membrane (Pl. XXVIII. fig. 12).

I was not able to examine the spicules of the marginal fringe. The pinuli of the gastral surface and of the associated diverticula differ from those of the dermal region in this, that the distal ray is slimmer, shorter, and not tufted, and that the four basal rays are both relatively and absolutely longer than those of the dermal pinuli. In the basal pad at the lower end of the sponge body, there are numerous strongly developed spicules with a variable number of rays which exhibit toothed rounded ends (Pl. XXVIII. figs. 10, 11.)

Among the Challenger material there is a basal tuft of strong spicules much encrusted with *Palythoa*, which bears a striking resemblance to the specimen figured by Bocage (*loc. cit.*), and very probably belongs to the species *Hyalonema lusitanicum.* I have figured it in its natural size in Pl. XXXIX. fig. 16, and have investigated the few persisting remnants of the sponge-body. The form was obtained at Station IV. to the south of Cape St. Vincent, lat. 36° 25′ N., long. 8° 12′ W., from a depth of 600 fathoms and a blue mud ground. From the upper end of the straight cylindrical form, which measures 20 cm. in length by 10 mm. in breadth, some broken basal spicules project. From the lower end shreds of a *Palythoa* encrustation hang down, but the bundle of spicules is broken off. That the somewhat conical point turned upwards in the figure, is really the superior pole, which supported the sponge-body, and had a few projecting spicules inserted in it, is best demonstrated by the examination of the few small remnants of the lost body, which persist loosely bound up with the *Palythoa* crust. The siliceous elements recognisable in the traces of the basal pad are firm spicules with six to two terminally rounded, cylindrical rays (Pl. XXXIX. fig. 17), which are beset with conical elevations of variable size either throughout their whole extent or only at their ends. On the larger conical elevations, small secondary teeth very frequently occur (Pl. XXXIX. fig. 18).

Unfortunately neither the results attained by Barboza du Bocage in his original research on *Hyalonema lusitanicum*, nor those of my investigation of the above described form, which is probably to be identified with Bocage's, are sufficient to establish any definite diagnosis of the form and structure of the species. Whether the much injured specimen which I examined in the British Museum is really the same as the root-tuft described by Bocage in 1864 is likewise doubtful, although the label certainly referred the specimen to the discoverer himself.

I ought not, however, omit to mention that in the Berlin Zoological Museum there is a well preserved *Hyalonema* form, obtained from Sir Wyville Thomson, and labelled as *Hyalonema lusitanicum*, Bocage. This specimen figured in Pl. XXXIV. fig. 1, does not, however, in its form and in its spicules, resemble the *Hyalonema* of the British Museum, but agrees in all essential points except size, with the *Hyalonema thomsoni*, Marshall. I was therefore compelled to describe it under the latter designation.

2. *Hyalonema cebuense*, Higgin.

The species of *Hyalonema* which Higgin described in 1875,[1] under the title *Hyalonema cebuense*, is not represented among the numerous forms of the Challenger collection. According to Higgin's account the form described must be a distinct species, and not—as Carter seems inclined to make out in his remarks on Higgin's article—a mere variety of *Hyalonema sieboldii*. The most important characteristics of the species are:—(1) the peculiar sculptor's-mallet-like form of the large body, which measures more than 14 cm. in length and 12 cm. in breadth; (2) the strikingly thick and short, straight, smooth oxydiacts, which are said to belong to the dermal skeleton;[2] (3) the peculiar small parenchymal oxyhexacts, which bear hook-shaped lateral spines at the ends of the rays;[3] (4) the slim double-harpoon-shaped oxydiacts, bearing all along both rays curved teeth turned towards the centre,[4] and finally (5) the presence of four blunt anchor teeth on the long spicules of the tuft.[5]

It is not evident from Higgin's otherwise accurate and detailed description whether a terminal sieve-net covers the gastral cavity, or whether the latter remains open, nor does he note the presence or absence of a fringe of marginal spicules. From the fact that no polype encrustation was observed on the upper end of the fibrous tuft, one cannot of course certainly infer its absence during life, since it might readily have been separated off.

3. *Hyalonema tenue*, n. sp. (Pl. XXX. figs. 1–8).

To the east of the mouth of the Rio de la Plata (Station 323, lat. 35° 39′ S, long. 50° 47′ W), from a depth of 1900 fathoms and a blue mud ground, two fragments of a *Hyalonema* were dredged, the siliceous elements of which appear to me sufficiently characteristic to justify the erection of a distinct species. One of the fragments has the form of a thin irregular plate about 2 cm. square in the middle of which a normal oval space, 6 mm. long by 4 broad, can be detected (Pl. XXX. fig. 1). This opening is

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xv. p. 377.
[2] *Loc. cit.*, pl. xxii. fig. 1.
[3] *Loc. cit.*, pl. xxi. fig. 5.
[4] *Loc. cit.*, pl. xxi. fig. 3.
[5] *Loc. cit.*, pl. xxi. fig. 9.

surrounded by a circle of radially disposed straight spicules, and as examination with a low power at once reveals, represents an oscular opening. The other fragment consists of a somewhat thicker (about 3 mm.) plate, with irregular ragged edges. On one surface smooth-edged oval or roundish pits occur, from which narrow diverticula pass towards the side and towards the interior (Pl. XXX. fig. 2). The other surface is rough and apparently damaged. This second specimen undoubtedly forms part of the internal wall of the body, and exhibits the surface limiting the gastral cavity and bearing the openings of the canals.

An examination of the siliceous elements shows, in the first place, that they are all strikingly slim and delicate, whence my choice of the specific designation *tenue*. Among the long spicules of the parenchyma, between the numerous slim oxydiacts, one remarks an unusual abundance of oxyhexacts of medium and small size (Pl. XXX. fig. 8), with thin, gradually pointed smooth rays. Besides these, though not so abundantly, small oxyhexacts occur with perfectly smooth curved rays (Pl. XXX. fig. 5). In the external skin, on the smooth hypodermal oxypentacts, and on the tangential oxydiacts, numerous autodermal pentact pinuli are inserted, with four smooth basal rays which are relatively long (0·2 mm.), while the slim, finely pointed distal, beset with minute obliquely inserted teeth, attains a length of almost 1 mm. The amphidiscs of the skin are of medium size (from 0·2 to 0·1 mm. in length) and with simple, straight-rayed, campanulate, medium-sized umbels, occupying one-third of the total length. The umbels never have eight, but always thirteen or twelve smooth, lancet-shaped, umbel rays. The axial rod is beset with nodes, which attain especially in the middle a considerable prominence and a cruciate disposition. The marginalia, which are radially grouped round the oscular opening, attain a length of 1½ to 2 mm. Their pointed proximal end is smooth, and not so long as the likewise pointed distal, which has a length of at least 1 mm. and is beset with oblique lateral teeth. On the boundary between the two rays, four cruciately disposed, globular tubercles project, the rudimentary representatives of the four tangential rays, as is readily demonstrated by the presence of a well-developed axial canal (Pl. XXX. fig. 7).

4. *Hyalonema robustum*, n. sp. (Pl. XXXII. figs. 1–10).

In the west of the North Pacific (Station 241, lat. 35° 41′ N., long. 157° 42′ E.), from a depth of 2300 fathoms and a red clay bottom, the fragment of a *Hyalonema* was dredged, which had the form and size of half an apple, and evidently represented about half the entire body of a sponge. On the convex external surface of the hemispherical specimen, the dermal membrane is well preserved as a fine-meshed network, while the torn internal surface exhibits a loose, wide-meshed parenchyma, with cavities increasing in width towards the interior.

Although I am not usually inclined to bestow specific distinction on such an imperfect specimen, it seemed to me justifiable to make an exception in favour of this form, on account of the marked breadth and strength acquired by the larger almost spherical amphidiscs, and also because of other peculiarities among the spicules.

The large supporting spicules of the parenchyma are more or less long diacts of variable strength, besides which isolated medium-sized, strong oxyhexacts also occur, as also very abundant slimmer medium-sized oxyhexacts, in which the rays are covered with slender spines inserted at right angles (Pl. XXXII. fig. 8). Between these a host of small smooth oxyhexacts with curved rays also occur (Pl. XXXII. fig. 6).

The dermal skeleton contains strongly developed hypodermal oxypentacts with proximal rays of variable length. On the tangential rays are inserted rows of autodermal pentact pinuli, with four short, strongly developed tangential basal rays, beset with short distally directed teeth, while the distal ray, about 0·3 mm. long, has a more bushy appearance, due to somewhat long obliquely inserted spines which are specially well-developed on the median and external portions (Pl. XXXII. fig. 7). Especially striking in the dermal membrane are the very broad, almost spherical, strongly developed amphidiscs (Pl. XXXII. figs. 1, 2), with broadly arched terminal umbels which almost meet in the middle. Each umbel consists of eight to twelve broad, paddle-shaped rays, which exhibit a median ridge projecting inwards and rounded off terminally. They do not pass into a terminal plate at the pole, but end sharply with a projecting margin round a central circular pit (Pl. XXXII. fig. 2). The opposed umbel rays are usually not exactly opposite but alternating (Pl. XXXII. figs 1, 2).

Besides these, the dermal membrane contains other amphidiscs, with eight slender umbel rays of smaller, and sometimes of much smaller size (Pl. XXXII. figs. 4, 5). The small umbels only occupy a third of the total length of the amphidiscs, or even less in the smallest forms (Pl. XXXII. fig. 5).

On the inner surface of the large internal cavity, in the gastral and canalicular membrane, numerous amphidiscs occur of medium and small size. They exhibit in part the same structure as those last described in the external skin (Pl. XXXII. fig. 4), and in part somewhat larger forms (Pl. XXXII. fig 3). Those large, almost spherical amphidiscs, which occur so abundantly in the dermal membrane, are here altogether absent, nor have I found any hypogastral pentacts or autogastral pinuli in the gastral or canalicular membrane.

In the lower portion of the body, which forms an annular pad, strongly developed spicules with six to two cylindrical rays occur. Their rounded ends are beset for a variable distance with teeth and spines (Pl. XXXII. figs. 9, 10), which often appear on the rudiments of undeveloped rays (Pl. XXXII. fig. 10).

Hyalonema species diversæ indefinitæ (Pl. XXXII. figs. 11–16; Pl. XXXIX. figs. 1–15).

Of the above-described species of *Hyalonema*, more or less perfectly preserved specimens were at my disposal, so that an approximately accurate investigation was possible, and diagnoses sufficient for the determination of the several species were obtained. But besides the above, the Challenger collection included several fragments which could be certainly enough referred to the genus *Hyalonema*, but not with any definiteness to any of the species previously known, or now established by my investigations. They belong to new, not yet described species. Following the frequent precedent of many investigators, I might have selected the most prominent characteristics of these forms, and used them for the erection of distinct species. I have, however, preferred to refrain from designating these imperfect and torn fragments, of which I should be unable to frame a description or diagnosis sufficient for their re-identification. I have, nevertheless, figured several of the more remarkable spicular structures of sponges from these localities for the use of future investigators, and by way of extending our knowledge of the variety of form within the genus *Hyalonema*.

Several large but insufficiently preserved fragments, referable to a sponge form about the size of one's fist, were dredged from the Mid-Pacific, near the Equator (Station 271, lat. 0° 33′ S., long. 151° 34′ W., where *Hyalonema depressum* was found), from a depth of 2425 fathoms and a Globigerina ooze ground. The smooth oxyhexacts and oxydiacts of the parenchymal skeleton do not exhibit any marked peculiarities. Small oxyhexacts are only represented by somewhat abundant forms with straight or slightly curved pointed rays (Pl. XXXII. fig. 15). The complete absence of small curved oxyhexacts essentially distinguishes this form from the species *Hyalonema depressum* found in the same locality. The hypodermal oxypentacts and oxydiacts of the dermal skeleton resemble, in form and size, the similar forms of *Hyalonema clavigerum*. The autodermal pentact pinuli are, however, peculiar, and resemble most closely the external pinuli of *Hyalonema robustum*. Like the latter, they exhibit short, strongly developed, and minutely spinose basal rays, and also a free, spindle-shaped, somewhat bushy distal, almost 0·4 mm. in length, beset with numerous rather long spines disposed like scales. The very end of the ray frequently exhibits a strongly developed, thick point, which is not very satisfactorily represented on Pl. XXXII. fig. 16.

The much extended, larger and medium-sized amphidiscs of the skin, are distinguished by the slender, delicate character of the slightly toothed axial rod, and also by the long umbels, which bear eight slender rays, and exhibit a campanulate form, somewhat truncated terminally. These forms of amphidisc differ greatly in size, as may be seen from some of the modifications represented in Pl. XXXII. figs. 11, 12, 13. Occasional giant-forms (fig. 11), 0·4 mm. or more in length, occur. Besides these, there is an abun-

dant occurrence of the familiar small amphidiscs with hemispherical many-rayed terminal discs (Pl. XXXII. fig. 14).

No hypogastral pentacts occur in the gastral skeleton, but their place is taken by strands of supporting diacts. The autogastral pentact pinuli are essentially different from the autodermal. They are not only decidedly shorter, and in no way so bushy as the latter, but they exhibit longer, less tuberculated basal rays, and are continued into a slender, pointed, terminal ray.

The oxydiacts, which form the long marginal fringe, bear a smooth, proximal ray, and a distal, beset with obliquely inserted spines, directed downwards and outwards. From the centre two or more, rarely four, rounded, or slightly pointed, lateral tubercles project.

A much torn fragment with isolated, broken tuft spicules, was trawled to the west of Cape York (Station 184, lat. 12° 8′ S., long. 145° 10′ E.), from a depth of 1400 fathoms, and a Globigerina ooze ground.

From the size of the shreds, and the thickness of the tuft spicules, it was to be inferred that the intact body had the size of an average apple. There are no definite indications as to the original form of the body.

In the parenchyma, besides long, narrow, smooth oxyhexacts and oxydiacts, small lank oxyhexacts occur, some with straight, and others with bent, smooth rays, though neither can be said to be abundant.

The dermal skeleton exhibits large, smooth, hypodermal oxypentacts, with tangential rays turned somewhat inwards, and long, slim, slightly spinose autodermal pentact pinuli with moderately long, and terminally spinose basal rays (Pl. XXXIX. figs. 5, 7). Amphidiscs of very various sizes and forms also occur. The larger exhibit a strongly developed axial rod beset with spines, and bear rather broad, campanulate umbels, composed of eight broad, paddle-like, terminally broad and rounded rays (Pl. XXXIX. figs. 2, 3). The length of these rays varies in relation to the total length of the amphidiscs, so that they sometimes attain to only a third of the whole length, at other times to about a half, and sometimes almost meet in the middle. The abundant medium-sized amphidiscs (Pl. XXXIX. figs. 4, 9) are slimmer, and bear narrower umbel rays in variable number. Each umbel usually consists of eight rays, but ten or twelve rays also occur. Finally, as in all species of *Hyalonema*, small amphidiscs with hemispherical many-rayed terminal umbels occur in great abundance. Some oxydiact marginalia were observed with smooth proximal, and shortly toothed, pointed, distal rays, while on the boundary between them, two or four rounded or slightly pointed tubercles projected (Pl. XXXIX. fig. 1).

In the South Atlantic, to the west of Tristan da Cunha (Station 333, lat. 35° 36′ S.,

long. 21° 12′ W.), from a depth of 2025 fathoms, and a Globigerina ooze bottom, a small irregularly torn fragment of *Hyalonema* was trawled. A small portion of the marginal fringe and of the superior sieve-plate was fortunately preserved. The parenchymal skeleton includes smooth, medium-sized oxyhexacts, smooth oxydiacts of various sizes, and small, somewhat roughened oxyhexacts, with straight rays. The hypodermal pentacts are strongly developed, of medium-size, and with smooth tangential rays, directed somewhat inwards. The autodermal pentact pinuli are slim and of moderate size. Their basal rays are rather long, and slightly spinose (Pl. XXXIX. figs. 13, 15).

The rather sparsely distributed larger amphidiscs of the skin are not very long (0·23 mm. and less), but with strong smooth axial rods and flatly arched, broad, short umbels, which consist of eight or seven broad paddle-shaped rays, pointed at the end like a Gothic arch (Pl. XXXIX. fig. 10). Medium-sized amphidiscs of similar structure are more abundant, while the small forms (Pl. XXXIX. fig. 11) with somewhat longer and more campanulate umbels also occur, and finally the familiar small amphidiscs with hemispherical umbels of ten to thirteen rays.

To the west of Luzon (Station 205, lat. 16° 42′ N., long. 119° 22′ E.), from a depth of 1050 fathoms and a blue mud ground, a ragged fragment of a Hyalonematid was obtained, which is in many respects very divergent from the hitherto described forms of *Hyalonema*. It is improbable, in fact, that it belongs to the genus, but rather to a type not yet investigated. From the nut-like fragment obtained, it was, however, impossible to draw any definite conclusions as to original shape and size of the sponge, except that it was probably about the size of an average apple.

It is very remarkable that the supporting spicules of the parenchyma are exclusively long slim pliable oxytriacts, with two long rays lying in straight line, and a third much smaller disposed at right angles accross the middle. Besides these, I have found only small oxydiacts and some oxytetracts, whose rays did not, however, lie in one plane. A large number of minute, very delicate oxyhexacts, with rather long, uniformly slender, straight rays also occur.

The dermal skeleton with its hypodermalia I have not been able to find, probably because of the absence of that layer. Autodermal or autogastral pinuli are, however, present in abundance. They are characterised by their medium-sized and somewhat bushy distal, and by the moderately long slender basal rays, which are somewhat thickened and toothed towards the end, though terminating in a sharp point. The amphidiscs vary greatly in size. Giants of 0·5 mm. occur, medium-sized forms one-third to one-fifth as large, and the ordinary small type. Most of the medium-sized amphidiscs have deeply campanulate terminal umbels with nine to four rays. I observed some large forms in which the opposite umbel rays had fused.

Genus 2. *Pheronema*, Leidy (Pls. XLII.–XLVI.).

Holtenia, Wyv. Thomson.

1868. Leidy, Proc. Acad. Nat. Sci. Philad., p. 9 (*Pheronema annæ*).
1869. Wyville Thomson, Ann. and Mag. Nat. Hist., vol. iv. p. 112.
1869. Wyville Thomson, Phil. Trans., vol. clix. p. 707 (*Holtenia carpenteri*).
1870. Leidy, The American Naturalist, vol. iv. p. 17 (March) (*Pheronema annæ*).
1870. Kent, Monthly Micr. Journ., p. 243.
1870. Kent, Ann. and Mag. Nat. Hist., vol. vi. pp. 182–186. { *Pheronema carpenteri* and
1870. Gray, Ann. and Mag. Nat. Hist., vol. vi. pp. 309–312. { *Pheronema grayi*.
1870. Schmidt, Die Spongien des atlantischen Gebietes (*Holtenia pourtalesii*).
1871. Carter, Ann. and Mag. Nat. Hist., vol. vii. pp. 112–141.
1871. Ehlers, Zeitschr. f. wiss. Zool., Bd. xxi. p. 540.
1872. Gray, Ann. and Mag. Nat. Hist., vol. ix. pp. 442–461.
1873. Carter, Ann. and Mag. Nat. Hist., vol. xi. p. 234.
1873. Carter, Ann. and Mag. Nat. Hist., vol. xi. p. 275.
1873. Carter, Ann. and Mag. Nat. Hist., vol. xii. p. 349.
1874. Meyer, Ann. and Mag. Nat. Hist., vol. xiii. p. 66.
1874. Gray, Ann. and Mag. Nat. Hist., vol. xiii. p. 284.
1875. Carter, Ann. and Mag. Nat. Hist., vol. xv. p. 113.
1875. Carter, Ann. and Mag. Nat. Hist., vol. xvi. p. 1.
1875. Marshall, Zeitschr. f. wiss. Zool., Bd. xxv., Suppl., p. 142.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii. p. 113.
1877. Zittel, Abhandl. d. baier. Akad. d. Wiss.
1877. Marshall and Meyer, Mittheil. d. Zool. Mus. in Dresden.
1877. Wyville Thomson, The Atlantic.
1880. Schmidt, Spongien des Meerbusens von Mexico.
1880. Norman, Ann. and Mag. Nat. Hist., vol. vi. p. 430.
1881. Milne-Edwards, Comptes rendus, vol. xciii.; Ann. and Mag. Nat. Hist., vol. ix. p. 37.
1881. Duncan, Journ. Roy. Micr. Soc., ser. 1, p. 173.
1881. Carpenter, The Microscope.
1885. Filhol, La vie au fond des mers, p. 285 (*Pheronema parfaiti*).

History.—In 1868[1] Leidy made a report on a sponge from Santa Cruz, which presents an oval form about 3 inches in size, and bears on one extremity a tuft of siliceous spicules about 2 inches in length, and differing from that of *Hyalonema* only in its smaller size. Afterwards he described this new form more accurately under the name of *Pheronema annæ*,[2] and he repeated his communication in 1870 in a paper illustrated by woodcuts and entitled Remarks on some Curious Sponges.[3] The latter description ran[4] thus:—" The body of the sponge is oblong ovoidal, with one side more protuberant than the other. The narrower extremity, which I suppose to be the upper, is conical, and its truncated apex presents a single circular orifice, the third of an inch in diameter. The opposite extremity is rather cylindrical, with a broad, slightly rounded

[1] *Proc. Acad. Nat. Sci. Philad.*, 1868, p. 9.
[2] *Proc. Acad. Nat. Sci. Philad.* (1868).
[3] *American Naturalist*, vol. iv. pp. 17–22, fig. 1.
[4] *Loc. cit.*, pp. 21, 22.

extremity, from which project numerous fascicles of siliceous threads. The sponge body is of a light brown hue, and rigid to the feel. Its surface exhibits an intricate interlacement of the sponge tissue, which appears mainly composed of stellate, siliceous spicules of various sizes. The coarser spicules of the surface have five rays. Four of these together are irregularly cruciform, while the fifth projects in a direction opposite to all the others. They appear to be so arranged that the crucial rays interlace with those of the contiguous spicules forming a lattice-work on the surface of the sponge, while the odd ray opposed to the others penetrates the interior of the sponge. The finer tissue, seen through the intervals of the latticed arrangement on the surface of the sponge, appears to be made up in the same manner of finer stellate spicules. Some of the longest stellate spicules of the surface have a spread of half an inch.

"The fascicles of siliceous threads projecting from the body of the sponge are upwards of twenty in number, and over 2 inches in length. They resemble in appearance tufts of blonde human hair. The individual threads are nearly like those proceeding from the lower end of Euplectella. Where thickest, they are less than the $\frac{1}{200}$ of an inch in diameter, and become attenuated towards the extremities. At first, as they proceed from the body of the sponge, they are smooth and then finely tuberculate. The tubercles are gradually replaced by minute recurved hooks, which become better developed approaching the free end of the threads, which finally terminate in a pair of longer opposed hooks, reminding one of the arms of an anchor. The objects of the tufts of threads, with their lateral hooklets and terminal anchors, would appear to be to maintain or moor the sponge in position in its ocean home."

Without knowing of these publications by Leidy, Wyville Thomson had in 1869 given a detailed and thorough account of a sponge designated *Holtenia carpenteri*, several specimens of which he had collected to the north-west of Scotland, from a depth of 530 fathoms in the course of his deep sea investigations in the "Lightning." The form of these specimens, which were about as large as one's fist, was "globular, elliptical or subcylindrical." A spacious and tolerably smooth central cavity, half the diameter of the sponge, diminishes superiorly to a round space of perfectly uniform breadth, while from the closed under side a tuft of numerous individual clusters of tolerably long, bow-shaped siliceous spicules doubtless rooted in the sand, runs out in a radial direction. On the lateral wall, and most abundantly near the upper surface, long radially directed spicules project freely, while the boundary of the wide superior osculum is formed by a compact wreath of vertical spicules measuring about 1 cm. or more in length. Both on the outer and inner surfaces of the tolerably firm cup-shaped sponge body, a firm rind is formed of strong compact siliceous spicules which lie in the skin, and are grouped together in stellate fashion, while the parenchymal mass itself is penetrated by a system of numerous cavities and canals. The siliceous spicules which penetrate and cover the entire organism resemble generally those of *Hyalonema*. The

form presents, however, so many peculiarities that the erection of a special genus seems to be justified, even apart from the different form of the body and its microscopic structure.

In a Notice of a New Vitreous Sponge—*Pheronema grayi*[1]— Saville Kent first justified the change of the generic title *Holtenia*, which had been applied by Wyville Thomson to his *Holtenia carpenteri*, into *Pheronema* (Leidy), on the ground of priority, since a generic agreement between the two species *Pheronema annæ*, Leidy, and *Holtenia carpenteri*, Wyville Thomson, cannot be doubted. He now brought forward a third species—*Pheronema grayi*—belonging to the same genus *Pheronema*. Of this several specimens had been procured during the expedition of the "Norna" off the coast of Portugal and in the neighbourhood of Setubal, from depths varying from 400 to 600 fathoms. This new species was further described and figured by Kent in the Monthly Microscopical Journal (1870, p. 243). *Pheronema grayi* is distinguished by the Portuguese fisherman as "Nidos de Mer," or "the sea bird's nest," being so named chiefly on account of the very broad and depressed form of the body, which is indeed very like the nest of a chaffinch, and also on account of the uniform distribution of the hair-like siliceous spicules over the whole surface, but especially on the inferior arched portion. These spicules are not arranged in bundles, but are isolated, and project for a greater or less distance, while in some specimens they are prolonged to form a very long basal tuft. Saville Kent also called attention to the fact that the shaft of the amphidiscs or "recurvate birotulate spicula" appeared to him to be rougher or "more profusely echinate," than in the case of the similar spicules of *Pheronema carpenteri*. "The sarcode investing and constituting the sponge body was of a brilliant orange colour."

Under the name of *Holtenia pourtalesii*, Oscar Schmidt described and figured in the same year 1870,[2] several sacciform sponges, some of which are provided with a superior oscular opening, while others are entirely closed. The form of these types, however, makes it difficult to refer them to this genus, or even to *Pheronema;* they are rather to be related, as Carter noted in 1875,[3] to *Rossella* (or *Lanuginella*, Schmidt). It is impossible to say whether a form designated by O. Schmidt *Holtenia saccus* belongs to *Pheronema*. It is described by O. Schmidt as "sacciform, the wide opening having very thin walls and irregularly projecting spicules." In the sarcode, according to Schmidt, "innumerable small hexradiate spicules occur, besides many five-rayed spicules with a projecting fifth ray, while whorl-like double anchors (amphidiscs) here and there occur. The sparsely distributed large hexradiate spicules and the long spicules are disposed on the incomplete meshes."

In some Notes on Anchoring Sponges,[4] Gray announced his inclination to unite

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. vi. pp. 182–186.
[2] Spongien des atlantischen Gebietes.
[3] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xv. p. 118.
[4] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. vi. pp. 309–312, 1870.

Pheronema grayi, Leidy, *Holtenia carpenteri,* Wyville Thomson, and other forms in a single family—the Pheronemadæ, which might be characterised by the "ovate globular or purse-like body, with a large internal cavity and outer walls formed of hexradiate spicules placed side by side, producing a tesselated surface formed of stars." For *Pheronema grayi,* Gray moreover, proposed the new generic name *Callisphaera,* and for *Holtenia saccus,* O. Schmidt, the generic name *Vazella.*

A somewhat different diagnosis was given by Gray in 1872[1] for his family Pheronemadæ in the words:—"Sponge oblong; outer surface formed of hexradiate spicules, lower surface with elongate filiform spicules ending in three recurved lobes." In this family he distinguished (*a*) those forms with "anchoring filaments arising in a circle of tufts around the base of the sponge," such as *Pheronema,* Leidy and Kent = *Holtenia,* Thomson, and (*b*) those with anchoring spicules arising from all parts of the sponge, such as *Callisphaera* = *Pheronema grayi,* Kent, and *Vazella* = *Holtenia,* O. Schmidt.

Under the designation of *Labaria hemisphærica,* Gray described, in 1873,[2] a sponge from Cebu, one of the Philippine Islands, sent through A. B. Meyer to the British Museum, with the following brief diagnosis:—"It is hemispherical, about 2 inches in diameter, and rather more than 1 inch high, with a rather smooth outer surface, and a rather deep regular concavity on the upper surface, which seems formed of interlacing spicules, leaving considerable spaces between them. The outer surface and its margin are scattered with distant, but rather regularly placed cylindrical perforations, from the centre of which are emitted tufts of elongated filiform spicules, diverging in all directions from the surface of the sponge. The middle of the underside deeply concave, with a well-defined edge, from which is emitted a very large tuft of very numerous crowded spicules, forming a kind of brush, each filament when perfect ending in three short recurved spines."

A detailed description of the same specimen was afterwards given by Carter[3] in which he also described the form and distribution of the various siliceous spicules, while the insignificant points of difference between these and the corresponding spicules of the genera *Hyalonema, Holtenia,* and *Pheronema* were pointed out.

In his great work on the Hexactinellida which Carter published in 1873,[4] and which contains a particularly detailed account of the form of individual siliceous spicules, *Pheronema annæ,* Leidy, *Pheronema grayi,* Kent, *Holtenia carpenteri,* Wyville Thomson (as well as *Meyerina claviformis,* Gray, which is further referred to below) are united into one group, which is characterised as follows:—"Species more or less globular, excavated, provided with anchoring spicules, and characterised by the birotulate flesh spicule above

[1] *Ann. and Mag. Nat. Hist.,* ser. 4, vol. ix. p. 450.
[2] *Ann. and Mag. Nat. Hist.,* ser. 5, vol .xi. p. 235.
[3] *Ann. and Mag. Nat. Hist.,* ser. 4, vol. xi. pp. 275–288.
[4] *Ann. and Mag. Nat. Hist.,* ser. 4, vol. xii. pp. 349–472.

mentioned. Anchoring spicules of two kinds, viz., smooth and spiniferous, the latter terminating at its free extremity in a recurved double hook, termination of the former unknown." On the other hand, *Labaria hemisphærica*, though closely allied, is so peculiar as to constitute a section by itself, with the following characteristics:—"Species possessing the birotulate flesh spicule, in which the termination of both kinds of anchoring spicules are known. Free termination of spiniferous anchoring spicules much the same as in the above mentioned; termination on the smooth anchoring spicule consisting of a double hook or arm, opposite, compressed, slightly recurved, and twice the size of the head of the spiniferous form." Carter placed Oscar Schmidt's *Holtenia pourtalesii* at a great distance from both of these groups, between *Crateromorpha* and *Rossella*, and characterised it in the following terms:—"Rosette many-rayed; rays multitudinous, of unequal length, straight and capitate, pappiform."

As the result of a thorough investigation which Higgin[1] was able to carry out on a well-preserved specimen of the *Labaria hemisphærica*, Gray, from Cebu, some errors in Carter's earlier description were corrected—errors which were mainly attributable to the fact that the specimen which Carter had studied was mixed up with foreign spicules belonging to another sponge. This was confirmed[2] by Carter himself, for he remarks, "that the anchoring spicules with spined shaft are abnormal." Carter also observes, that "while the shafts of the anchoring spicules of *Labaria hemisphærica* and of the genus Rossella are all smooth, those of Hyalonema, &c., are *all spined;* and that the latter only appear to be sometimes smooth from the spines being continued upwards from the free end for a less distance in some than in others."

In his notes on the affinities of the Hexactinellida, Marshall observes,[3] that "Labaria and Pheronema are clearly very closely related to one another, and perhaps scarcely separable generically;" and further, that "*Holtenia saccus*, O. Schmidt, is also related to Pheronema, though it does not belong to this genus."

Among the sponges which were collected by the French Expedition of the "Travailleur" in the Bay of Biscay, Norman also records *Holtenia carpenteri*.[4] According to the report of Oscar Schmidt,[5] a typical specimen of *Pheronema annæ* was found in the neighbourhood of Santa Cruz, at a depth of 180 and 248 fathoms. A special genus *Leiobolidium* has been established by Oscar Schmidt for a spherical sponge measuring 15 mm. in diameter, soft and smooth to the touch, resembling in general habit and softness a delicate Reniera, and exhibiting the same microscopic component elements as Pheronema. "At the one pole there is an osculum surrounded by a rim, over against this there is a small irregular depression from which a root-tuft seemed to have been torn."

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xv. p. 385.
[2] *Loc. cit.*, p. 389.
[3] *Zeitschr. f. wiss. Zool.*, 1876, vol. xxvii. pp. 113–136; *vide* p. 130.
[4] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. vi. p. 436.
[5] Die Spongien des Meerbusens von Mexico, 1880, pp. 64, 65.

The specimen was found at Bequia, at a depth of 1507 fathoms, on muddy ground.

Monsieur Filhol, in his preliminary review of the chief results of the voyages of the "Travailleur" and of the "Talisman,"[1] gives the following brief notice in regard to the genus *Pheronema*:—"Les Pheronema paraissent être répandus dans tout l'Atlantique, dont elles habitent en certaines points de très grandes profondeurs. Communes sur la côte du Portugal, elles apparaissent encore plus nombreuses au large des côtes du Maroc et du Senegal. Nous les avons prises à partir de 600 mêtres jusqu'à 2200 mètres. Dans un dragage exécuté à 4789 mètres le chalut a rapporté des débris d'une éponge brisée, qui semblait avoir dû être à un Pheronema. Les espèces nous ont paru devoir être varieés. Certaines d'entre elles sont remarquables par un énorme developpement, alors que d'autres, telles que les Pheronema Parfaiti (*loc. cit.* fig. 92), se font remarquer par leur transparence et l'absence de collerette des spicules autour de l'oscule. La coloration des Pheronema, que nous avons capturés, était brunâtre, et nous n'avons jamais eu l'occasion d'observer la belle coloration d'un rouge orangé, dont M. Saville Kent a fait mention, à propos d'une espèce de Pheronema qu'il avait capturé dans les environs de Gibraltar."

Characters of the Genus.—The lower end of the cup- or goblet-shaped, thick-walled body, is continued into a broad, not always sharply defined root-tuft of basal prostalia, while from the lateral surface tufts of pleural prostalia project. The circular oscular margin is surrounded by a cuff-like fringe of freely projecting marginal prostalia, which seem, however, to be absent in one species,—*Pheronema annæ*, Leidy. The parenchyma of the body contains uncinates. The basal tufts consist of tolerably elongated *bidentate* anchors. The marginalia and many of the pleuralia end in club-shaped thickenings.

1. *Pheronema annæ*, Leidy (Pl. XLII.).

The kindness of my esteemed fellow-worker O. Schmidt of Strassburg, placed at my disposal for examination a dry specimen of *Pheronema annæ*, Leidy. Like Leidy's original specimen, this form was got at Santa Cruz, W. I., from a depth of 180 or 248 fathoms. It is represented in natural size, from a photograph, on Pl. XLII. fig. 1. The body is about 11 cm. in length, and in the middle 5 cm. thick, exhibiting on the whole a long, oval form, though the upper half is narrowed to a transversely truncated end, 2 cm. in breadth. The broad lower portion is also somewhat truncate, with a breadth of about 3 cm., and from it there projects a number of slim, isolated tufts of basal spicules (5 to 6 cm. in length). Minute, slender bundles of shorter (2 to 3 cm.) straight, rod-like spicules are disposed radially, but in irregular distribution, over the whole lateral surface of the sponge, without however anywhere forming a closed wreath. Nor is there any special

[1] La vie au fond des Mers, 1885, p. 85.

fringe of spicules on the somewhat sharpened, oscular margin of the gastral cavity. On the outer surface of the body, between the radial groups of spicules, one can see the characteristic network formed from the tangential rays of the hypodermalia, while on the inner surface of the gastral space irregular groups of closely adjacent, minute, circular apertures (0·5 to 1 mm. in diameter) penetrate, like sieve pores, the somewhat uniform, curved, smooth wall. In the parenchyma, I have only been able to find quite isolated, large and middle-sized hexacts. Beside the long, radial rays of the large hypodermal or hypogastral pentacts, a great number of various diacts occur, and small oxyhexacts in special abundance. The latter are for the most part long and slender, but in part also comparatively short. Only a few are smooth; most of them bear somewhat closely apposed spines turned in the same direction. They may perhaps be thus best described as uncinates. Others occur in which the long, median portion is smooth, but the ends beset with spines.

Some of the very long, slender uncinates, which usually occur in bundles, bear several simple, obliquely projecting, or almost apposed bars; while others exhibit, below each slender pointed, almost appressed spine, a minute, longitudinal furrow or rib, as has been figured by Wyville Thomson in *Pheronema carpenteri* (*loc. cit.*, pl. lxviii. fig. 4). The short and rather thick uncinates have on an average a length of only 0·5 to 1 mm., and bear spines of very varied length, and occasionally quite rudimentary (Pl. XLII. fig. 6).

The small oxyhexacts have an average diameter of 0·14 mm., and are characterised by transverse, rather blunt, externally directed, slender and somewhat bent spines, longest in the middle of the rays, and decreasing towards the ends (Pl. XLII. fig. 12).

The very strongly developed dermal skeleton exhibits strong hypodermal oxypentacts with long smooth rays, which are not however always at right angles to one another. The proximal radial ray is indeed usually at right angles to the four tangentials, but these frequently form acute or obtuse angles, or are bent near the point of intersection into the tangential plane. The rays of these large smooth oxypentacts are as a rule straight, but slight curvatures not unfrequently occur, either in simple or in S-shaped fashion.

The pinuli of the external skin are moderately large oxypentacts, with four rather long, slender, tangential bases, which are rarely quite smooth, in fact, usually beset with more or less long, oblique, externally directed spines. The oblique somewhat externally bent spines of the more or less long free distal ray vary in abundance. They sometimes produce an almost bushy appearance, and are longest in the middle of the ray (Pl. XLII. fig. 10). The dermal amphidiscs vary greatly in size and form. The largest are between 0·2 and 0·3 mm. in length, and exhibit a strongly developed axial rod with hemispherical tubercles and expanded campanulate umbels with eight smooth lancet-shaped umbel rays (Pl. XLII. fig. 2). Besides these, numerous amphidiscs of medium size occur, measuring 0·05 to 0·1 mm. in length, with a slightly tuberculate axial rod and eight

slender umbel rays, which vary considerably in length in different amphidiscs, and are often markedly divergent (Pl. XLII. fig. 3). The smaller and smallest amphidiscs, varying from 0·04 to 0·02 mm. in length, bear short, approximately or perfectly hemispherical terminal umbels, with eight, twelve, or more slender umbel rays (Pl. XLII. figs. 4 and 5).

The firm skin which lines the long cylindrical gastral cavity is supported by strong smooth hypogastral pentacts, which entirely resemble the already described hypodermalia. The bushy autogastral pentacts are also exactly similar to the autodermals. I did not find here the largest form of amphidisc, with broad paddle-like or lancet-shaped umbel rays, but the medium-sized and small forms were present in abundance, as in the skin. On the internal surface of the numerous large ramified efferent ducts, which occur in the gastral walls, hypocanalicular oxypentacts with canalicular pentact pinuli occur, but the latter are different from the autodermal and autogastral forms in this, that their four, sometimes smooth, sometimes spinose basal rays are on an average longer, and the freely projecting ray less thickly beset with lateral curved spines (Pl. XLII. figs. 8, 9, 12, 13). The further the efferent canal system is followed towards the chamber parenchyma, the less conspicuous, the more slender and sparse do the pinules become, and the weaker is the development of the spines on the freely projecting ray (Pl. XLII. fig. 11) until they finally disappear just before the orifices of the chambers.

The spicules, which project radially in long tufts from the lateral surface, are diacts or uncinates, either smooth or covered with barbs. The long bundles, projecting at the lower end consist of spicules, which are smooth at the upper pointed end, while the lower is beset with spines, bent obliquely upwards and outwards, and usually distinctly disposed in two opposite rows. Somewhat above the extremity the spines disappear, and the spicule ends in an anchor structure, which exhibits two, more or less long, slightly recurved, opposite teeth (Pl. XLII. fig. 7). Three such teeth exceptionally occur. If two anchor teeth are formed, as is usually the case, they lie in the same plane as the biseriate alternately disposed barbules of the shaft (Pl. XLII. fig. 7).

2. *Pheronema carpenteri* (Wyville Thomson) (Pl. XLIII.).

On the "Lightning" Expedition in the north of Scotland, Wyville Thomson found, at a depth of 530 fathoms, some beautiful sponges which he described and figured in a masterly fashion[1] under the title *Holtenia carpenteri*. Of these I obtained for examination some spirit and dried specimens captured by Wyville Thomson himself on the "Lightning" and "Porcupine" Expeditions, and other specimens well-preserved in alcohol, which were dredged by Mr. John Murray on the "Triton" Expedition. On the Challenger Expedition several much torn portions of this Hexactinellid were trawled on

[1] *Phil. Trans.*, 1859, p. 701.

the Brazil coast, off Macio, to the east of the mouth of the San Francisco (Station 124, lat. 10° 11′ S., long. 35° 22′ W.), from a depth of 1600 fathoms, and a red mud ground. Several portions of the basal tuft, and of the lateral wall, with vestiges of the external skin, are alone preserved.

For my study of the tissue and the disposition of the various spicules, the specimens collected by Mr. John Murray were especially satisfactory, owing to their excellent preservation in absolute alcohol. These specimens exhibited an ellipsoidal form, and the body measured, exclusive of the basal tuft, 5 cm. in length, and 4 to 5 cm. in maximum breadth. The circular oscular opening at the superior pole is surrounded by a wreath of vertically projecting, marginal spicules, has a diameter of 12 mm., and leads into a smooth-walled, cylindrical, inferiorly truncated gastral cavity, 25 mm. in depth. From the whole external lateral surface, fine, pointed, radial spicules project in loose bundles, 2 to 3 cm. in length. These are, however, irregularly disposed, with the exception of certain closely set, somewhat longer spicules, which form an annular zone, a few mm. in breadth, about 10 mm. below the marginal fringe. On the lower basal end of the sponge, there is a large number of slender (1 to 2 mm. in breadth) tufts of long flexible spicules, 30 to 40 cm. in length, which interlace abundantly in the thick felt-work of the basal tuft. The individual slender bundles are however distinctly separate as they issue from the sponge-body. The external surface of the sponge exhibits a delicate dermal network, marked, especially in the dried specimens, by stellate knots at tolerably uniform intervals (Pl. XLIII. fig. 1).

The *ellipsoidal* shape may be regarded as characteristic of the general form of the body (*cf.* Pl. XLIII. fig. 1, and Wyville Thomson, *loc. cit.*, pl. lxvii., pl. lxix. fig. 1), although a comparative survey of all the forms before me reveals a slight difference in this, that the larger, and therefore probably older specimens, are somewhat more drawn out longitudinally, the smaller younger forms are approximately spherical, while the very smallest, less than a pea in size, often exhibit, as Wyville Thomson has shown, the form of a hen's egg with an inferior pointed pole (Wyville Thomson, *loc. cit.*, pl. lxxi.).

As is noted in Wyville Thomson's careful investigation of the siliceous spicules of *Pheronema carpenteri*, the parenchyma, which is on the whole only slightly massive but is penetrated by countless lacunæ and wide passages, contains among the larger independent strictly parenchymal spicules, medium-sized, rarely large oxyhexacts, while long, slender, flexible oxydiacts predominate. These are either smooth or thickly beset with appressed uniformly directed barbs, and are for the most part radially disposed towards the external or gastral surface, with the distal pointed end projecting for a variable distance beyond the surface. Besides these, there are in the parenchyma a large number of short, strongly developed uncinates, 0·2 to 0·3 mm. in length, with but short spines or barbs (Pl. XLIII. fig. 5). Finally, there occur in the parenchyma small simple oxyhexacts, with smooth straight rays. That the strong and somewhat large smooth

oxypentacts, which form the main support of the dermal, gastral, and canalicular skin, and which here and there appear to lie quite within the parenchyma, are really to be regarded as true parenchymalia, does not seem to me probable. As a rule I could readily connect them with the above named surfaces, and thus regard them as hypodermal, hypogastral, and hypocanalicular elements respectively.

The dermal skeleton has for its supporting basis large, strong oxypentacts, in which the four long smooth tangential rays are usually indeed all but straight and crossed at right angles, though not unfrequently somewhat curved, and in their inclination to one another more or less diverted from a right angle. They are frequently disposed not exactly tangentially, but slightly inclined inwards. The likewise long and strongly developed, smooth, straight, proximal ray is, as a rule, at right angles to the surface ; it may, however, in certain cases, for instance in the immediate neighbourhood of the marginal boundary, deviate from this exactly radial disposition. The tangential rays of the adjacent hypodermal pentacts lie for the most part in long stretches close to one another, and thus form a strong, quadratic, dermal lattice-work, in the meshes of which the sieve network of the dermal membrane is spread out. The quadratic skeletal meshwork is, however, in no way uniformly composed, but numerous deviations and displacements occur all over. The skin is externally beset with autodermal pentact pinuli which are more or less roughened. Their tangential basal rays are of considerable length and almost always smooth, but rarely tuberculate towards the end, while the moderately long (0·15 to 0·2 mm.) radially projecting distal is smooth below, but on the outer three-fourths of its length beset in fir-tree-like fashion with strongly developed lateral spines (Pl. XLIII. fig. 4). It is noteworthy that these dermal pinuli are in no way so abundantly or thickly present as is usual in the other Hyalonematids; in certain positions, indeed, they are sparsely present or have a quite isolated occurrence. Especially near the oscular margin they are only to be found here and there among the especially abundant pleural *prostalia* (Pl. XLIII. fig. 2).

As to amphidiscs, I found, in the external skin of the North Atlantic specimens, only the small (0·03 to 0·05 mm.) eight-rayed form (Pl. XLIII. figs. 6, 8) with short hemispherical umbels. In the remains of the Brazilian specimens, however, besides the above forms, larger eight-rayed amphidiscs of similar form (Pl. XLIII. figs. 9, 10) occurred. I hesitate, however, before proposing to erect a distinct species on the strength of this single deviation.

In the compact gastral membrane the skeletal elements are disposed in essentially the same way as in the external skin. The following deviations are, however, of some interest. In the first place, the whole free surface is much more closely and uniformly beset with pinuli, and these pinuli differ from the autodermal forms in this, that they are for the most part, especially in the neighbourhood of the oscular opening, bent by the stream of water towards the efferent aperture (Pl. XLIII. fig. 2). The

small amphidiscs here are equal in abundance, and similar in form to those in the outer skin.

Even the larger afferent and efferent canals are furnished with pinuli, though in rapidly decreasing size and strength. The small amphidiscs also extend for a considerable distance as *canalicularia*.

In regard to the numerous radial pleuralia which project to a greater or less distance beyond the surface of the sponge, the uncinates proper demand special notice. These are long oxydiacts which are thickly surrounded by appressed barbs. They occur chiefly at the upper end in the neighbourhood of the oscular margin, and are always radially disposed so that the pointed ends of the barbs are directed inwards, and the anterior point of the whole spicule outwards (Pl. XLIII. fig. 2). Wyville Thomson has figured a specimen of such a long (up to 8 mm.) pleural uncinate (*loc. cit.*, pl. lxviii. fig. 4). Besides these a large number of cylindrical spicules of various calibre occur, frequently in the form of thin, coiled threads, which gradually decrease in thickness, towards both ends from a maximum diameter about the region of the external surface of the sponge. They terminate internally in a simple point, while the outer extremity generally evades observation owing to breakage. They are usually smooth, either altogether or for the greater portion of their length. Although these long, smooth, pleural prostalia are for the most part broken, and the external extremity only uncertainly distinguishable, a few seem to be intact. I was unable to decide whether there are any, or if so how many, pleuralia which run out externally into a point. Most of the long, projecting, smooth spicules gradually become thinner and thinner towards the extremity, but the fact that the terminal portions themselves are broken off, suggests that they do not simply form points, but terminate like the shorter forms about to be described, in which the outer ends were preserved. On several of the thin fibre-like pleural spicules, which are quite smooth on their internal pointed portion, one notices further outwards the appearance of small teeth, at first very inconspicuous, but afterwards gradually more prominent and spine-like. These are directed transversely or somewhat obliquely outwards. The outer or most external spinous portions of these pleuralia finally terminate in a club-shaped swelling with four cruciately disposed lateral elevations and a single terminal point. The lateral points either project transversely, or are directed obliquely outwards; more rarely they are bent somewhat inwards. In some instances it was possible to recognise in this terminal knob a hint of an axial canal intersection, corresponding to the five conical teeth.

These spinose monacts occur especially on the upper portion of the sponge-body. I have repeatedly found, even in the neighbourhood of the oscular margin, similar monacts of smaller size (2 to 3 mm.), which projected but slightly from the surface of the skin, and were throughout their whole extent, from the internal pointed end to the external terminal knob, uniformly thickly beset with small spines directed transversely or obliquely outwards (Pl. XLIII. fig. 2).

Finally, the pleuralia include isolated two-toothed, very rarely three-toothed, anchor forms with a strong shaft bearing barbs. These occur more abundantly towards the base, and seem to be wholly absent from the upper end of the sponge-body. The inner portion of these spicules, which vary greatly in length, is smooth, and ends in a simple uniform point. On the outer portion inconspicuous tubercles first appear, these are succeeded by larger forms, which finally pass into strongly developed spines pointed backwards and slightly recurved. In the portion of the anchor shaft which is surrounded by barbs the diameter of the spicule rod decreases gradually outwards. Just in front of the end which bears two simple anchor teeth the barbs disappear, and the diameter again increases on to the thickened end with its slightly arched apex. From the latter the two strong roundish (about 1 mm. in length) anchor-teeth originate laterally in a distal plane. They extend opposite one another—smooth and slightly curved—and are directed obliquely outwards and backwards. In abnormal cases three similar anchor teeth occur, forming equal angles with one another, or the number may be reduced to one.

The basalia forming the numerous slender tufts[1]—about 2 mm. in thickness—which project from the lower rounded end of the sponge, are for the most part of great length, and may in the larger specimens, as Wyville Thomson has shown, measure several decimetres. They are, on the whole, stronger than the pleuralia, and form in spirit or dried specimens a thick feltwork, between the fibres of which, portions of the substratum and all kinds of foreign bodies are included (Pl. XLIII. fig. 1). In their upper portions all the fibres are smooth, while externally they exhibit, for the most part, perhaps without exception, the curved barbs described above in connection with the shaft of the pleural anchors. Like the pleural anchors, further, they pass by a smooth cylindrical neck to a thickened terminal portion with two more or less large recurved anchor teeth.

The marginalia surrounding the circular margin of the oscular aperture form a closed wreath—a few spicules in breadth—and consisting either of long, strongly developed uncinates like those which occurred among the pleuralia, or of perfectly smooth, internally pointed, externally narrowed spicules of various calibre, which probably end in a point or in a spinose portion with terminal knob.

While on the internal surface of the gastral cavity of the Hyalonematids no spicules projected except the pinules, in this form numerous uncinates occur in the neighbourhood of the marginal fringe, arranged in tufts directed inwards and upwards, and projecting freely for about half their entire length into the lumen of the gastral cavity (Pl. XLIII. fig. 2).

[1] Oscar Schmidt has, in his Spongien des Meerbusens von Mexico (p. 65), maintained that the *Pheronema* figured by Saville Kent (*Monthly Micr. Journ.*, 1870, pl. lxiii. fig. 1) is not Wyville Thomson's *Pheronema carpenteri*, but *Pheronema annæ*, Leidy. With this opinion I cannot agree. The basalia do indeed protrude as in *Pheronema annæ*, but the same occurs in *Pheronema carpenteri*, though to a less marked degree. Besides, as Saville Kent notes, the specimen was much macerated, so that the individual bundles of basalia were naturally isolated.

As to the young specimens, from 10 to 5 mm. in size, so thoroughly studied by Wyville Thomson, it is to be noted further that besides the already mentioned ovoid form of the body, the slender development of the fir-tree-like distal ray of the dermal pinules is striking.

3. *Pheronema grayi,* Sav. Kent.

This Portuguese species is distinguishable, even on external macroscopic inspection, by its likeness to the nest of a chaffinch, and by the scattered disposition of the lateral and basal prostalia, which are not grouped in bundles. Though there was no specimen at my disposal for more intimate study, I shall attempt to sum up the characteristics on the strength of the descriptions and figures before me, and as the result of notes which I made on some specimens in the British Museum. The breadth and height of the two-third spherical form are approximately equal, and measure 10 to 12 cm. The loose beard-like root-tuft has a length of 26 to 60 cm. or more. The circular oscular aperture measures 5 cm. in diameter, and bears on its margin a continuous annular fringe of perpendicularly projecting needles, of which the freely projecting portions are about 10 cm. long. While the prostalia lateralia over the rest of the external surface are uniformly but sparsely scattered, there is here, as in *Pheronema carpenteri,* a thicker zone, about 12 mm. below the marginal fringe. The zone consists of pleuralia, projecting radially, or directed somewhat obliquely outwards and upwards. When the sponge was brought on board " the sarcode investing and constituting the sponge body was," according to Saville Kent (*loc. cit.,* p. 284), " of a brilliant orange colour."

In regard to the spicules, it is to be noted that they essentially agree with those of *Pheronema carpenteri,* and from the report which I have given above in regard to the prostalia of *Pheronema carpenteri,* it will be seen that even " the long attenuate spinulate forms and others with straight spines " which Saville Kent figures as characteristic of *Pheronema grayi,* are not absent from the former. It is possible that the spinose needles with a five-pointed terminal and external knob, which I found in *Pheronema carpenteri* projecting as lateral prostalia from the neighbourhood of the oscular margin, are absent in *Pheronema grayi,* but this supposition requires to be corroborated by direct investigation, which I have not been able to accomplish.

4. *Pheronema hemisphæricum* (Gray).

As W. Marshall has noted, the genus *Labaria* erected by Gray (with a single species, *Labaria hemisphæricum,* Gray), cannot be separated from *Pheronema,* Leidy. This form (from the Philippine Island, Zebu) has been described by Gray, Carter, and with special

thoroughness by Thomas Higgin, and the result is to show that it must simply be included in the genus *Pheronema.* Since I have not myself been able to examine *Pheronema hemisphæricum,* I will here content myself with citing the last and most thorough description, that of Higgin,[1] and with shortly summarising the most essential characteristics.

According to Higgin, the sponge is in form " like a small bird's nest, the bottom of which is flat, with a well-defined edge: the sides are rounded; and the sponge attains its greatest diameter about one-third of the way down from the edge of the hollow of the nest, towards the base." According to his figure on Pl. XXII. fig. 3 the shape is like that of a prehistoric Greek clay urn, and exhibits a convex surface above and below the annular pad which occupies about the median third of the lateral wall. The maximum transverse diameter measures about 10 to 12 cm., and the height about 9. The upper flatly spherical cavity is at the margin 8 to 9 cm. in width, and is 4 cm. deep. The length of the anchor needles in the basal tuft is 8 to 9 cm. On the superior, sharply defined margin there is a wreath of varying length and 1 to 3 cm. in breadth, composed of long straight pointed spicules, which project at right angles. The lateral usually projecting annular zone is covered with " whisker-like bundles of long spicules which issue from circular holes the edges of which are slightly raised, each bundle consisting of a dozen or more spicules. Around the circumference of the base are arranged loose fascicles of anchoring spicules, from 7·5 to 8 cm. in length, and having a diameter of about 12 mm. measuring along the edge of the base, by 6 mm. to 10 mm. A few scattered short spicules project here and there from the base generally, but there are no bundles other than those around the edge. The anchoring spicules are of one kind only, viz., smooth, fusiform, terminating at the free end in two opposite hooks; there are no spined forms. The spicules of the whisker-like tufts are plain, fusiform; the spicules of the erect fringe round the labrum are also fusiform and smooth throughout, but there is an appearance of spines on some towards the free end." In the surface reticulation T. Higgin found four kinds of spicules—" (1) pentacts, whose four tangential arms are equally smooth and opposite or at right angles to each other, inclined slightly downwards or inwards; the shafts of the larger spicules are 12 mm. long; (2) long, slender, acerate spicules, thickly covered with short sharp spines, all pointing towards one and the same end of the shaft; (3) smooth acerates with the cross on the central canal; (4) plumose spicules, of shapes intermediate between one with a very thick shaft, short and bushy looking, with long, strong, bluntly ended arms, and another with small, short, fine arms and a long feather-like shaft; the crucial arms of which, thickly studded with short obtusely pointed spines, are bent downwards, as if to embrace or fit to the arms of the large spicules on which they rest. The strongly woven together basket work of the interior, as seen through the investing network, is composed of:—(1) smooth spicules of the sexradiate type (that is, *acerate* with simply

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xv. p. 377

a central cross indicating their Hexactinellid character); (2) *acerate* with four tubercles at the middle of the shaft; (3) sparsely spined acerates, the spines bent towards the middle of the spicule; (4) four-rayed, (5) five-rayed, and (6) six-rayed spicules, the long arms of which are bent together in all varieties of ways; among these are (7) large and small eight-armed birotulates with dome-shaped heads, and some very minute ones; (8) small sexradiate spinules, the arms of which are furnished towards the free end with three, four, or five long spines projecting in the direction of the free end; also (9) a small acerate spicule in great abundance *peculiar to the species*, furnished with fine spines not very close together, all of which are bent towards one end of the spicule, increasing in length along one-third of the spicule (viz., from the end from which they look), and then gradually diminishing again from this point to the other end of the shaft; and (10) plumose spicules in great variety."

5. *Pheronema globosum*, n. sp. (Pl. XLIV.).

Besides several other Hyalonematids, some specimens of a *Pheronema* were obtained from Station 192 of the Challenger Expedition, near the Little Ki Island (lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.) from a depth of 129 fathoms and a blue mud ground. At first I was inclined to regard the latter as identical with the above described *Pheronema hemisphæricum*, Gray, from the Philippine Island, Zebu. The specimens before me, however, which are for the most part well preserved in spirit, differ so markedly both in external appearance and in the structure of many of their spicules from the latter species, that a separation is certainly necessary. While the smaller specimens, with a diameter of 20 to 25 mm., have an almost spherical appearance, and only exhibit at the superior pole a hemispherical depression with a strong-margined aperture, 10 cm. in diameter, the larger forms, 9 to 10 cm. in breadth and 6 cm. high, have the form of a superiorly truncated and somewhat depressed three-quarter sphere. The circular terminal opening of the shallow hemispherical gastral cavity, 3 to 4 cm. in depth, measures 5 to 6 cm. in breadth, and exhibits a somewhat sharply defined edge, under which a gentle protrusion inwards is distinctly visible. From this oscular margin a wreath of pointed spicules projects perpendicularly for 12 to 15 mm. In the external dermal layer there is a tolerably firm irregularly shaped network, which bears at intervals of $1\frac{1}{2}$ to 2 cm. small knots with slight boss-like projections (Pl. XLIV. fig. 1). From each such boss a tuft of eight to twelve blunt spicules projects radially, attaining a length of 3 cm. and more. The whole uniformly convex basal surface is furnished with these tufts of spicules, at approximately equal intervals, and that all over, not merely forming a circle, or leaving the central portion free (as Higgin described in *Pheronema hemisphæricum*). The spicules of these basal tufts far exceed the pleural in number, and still more in length. The normal length of the basal tuft, which is in all the specimens much thickened

and felted, is difficult to estimate. In the largest forms it cannot be less than 10 to 20 cm.

The concave internal surface of the upper gastral cavity exhibits a tolerably firm and solid portion, about 10 mm. in breadth, and arched slightly inwards, while all the rest of the surface forms a tolerably well-differentiated quadratic lattice-work, the strands of which enclose meshes, 2 mm. or less in width.

From this description, and from the figure in Pl. XLIV. fig. 1, drawn from a photograph, the external specific differences between *Pheronema globosum* and *Pheronema hemisphæricum,* Gray, must be evident enough. As to parenchymal spicules, mention must be made of (1) the numerous rather large oxyhexacts, with long, straight, or slightly curved smooth rays, which are sometimes reduced in number so as to result in pentacts, tetracts, or triacts; (2) medium-sized smooth oxydiacts, which are for the most part somewhat bent; (3) long radial uncinates, reaching as far as the surface or even further; (4) very numerous short uncinates, which though especially abundant round about the efferent canals, occur in varied disposition, and are distinguishable from the long uncinates not only by their smaller size, but also by this, that the strong laterally inserted spines are curved, and somewhat markedly divergent; (5) slender oxydiacts of rarer occurrence, with strongly developed, or almost wholly reduced spines (Pl. XLIV. figs. 4, 7).

The numerous medium-sized and small amphidiscs (Pl. XLIV. fig. 3) which occur in the parenchyma, do not, in my opinion, really belong to it, but owe their origin to the outer skin, or to the membrane of the gastral or canalicular cavities, whence they have been forcibly pushed or floated into the parenchyma.

The dermal skeleton includes strong hypodermal oxypentacts with long, smooth, straight or slightly bent rays, measuring 10 mm. or more in length (Pl. XLIV. figs. 8, 9). The four tangential rays are inclined slightly inwards (Pl. XLIV. fig. 9). Numerous strongly developed autodermal pentact pinuli also occur, exhibiting a somewhat thick, bushy, free distal ray, thickly beset with strong, bent, lateral spines, and four moderately long, blunted basals, slightly inclined inwards, and thickly beset with short spines, (Pl. XLIV. figs. 3, 5). In various places the distal ray of the pinuli is somewhat more slender, of greater length, and slightly curved.

As to amphidiscs, I observe a large form, 0·2 mm. long, with campanulate but rather short terminal umbels, in which the eight, or more rarely six, umbel rays are tolerably smooth, and moderately rounded in paddle-like fashion (Pl. XLIV. fig. 6). The rather thick stalk is richly beset with roundish tubercles. Besides these, somewhat small amphidiscs occur, with exactly similar form, and finally very small forms, 0·02 mm. or less in length (Pl. XLIV. figs. 12, 13).

The dermal skeleton of the gastral cavity resembles that of the outer skin, except in this, that the pinules are furnished with a much longer and more slender distal ray.

The pleural prostalia consist of the long, more or less markedly projecting uncinates,

but for the most part of long spicules, of which the internal portion buried in the body is wholly smooth and runs out into a point, while the outer freely projecting portion (2 to 3 cm. in length), though, indeed, for the greater part of its length also smooth, is in the neighbourhood of the outer termination beset with teeth, directed obliquely outwards, and either runs out into a point, or exhibits a club-shaped thickening, with one terminal, and four cruciately disposed lateral points. Since most of the pleuralia are broken off, it is difficult to determine which mode of termination is the more abundant, and whether there are not here also spicules which are quite smooth on to the very end.

The marginalia, which project in a perfectly continuous series for 12 to 15 mm., and become narrowed towards their outer end, are always quite smooth in their inner pointed portion. Towards the exterior they bear small spines projecting obliquely outwards, and end in a sort of lance-like point.

The basalia (Pl. XLIV. fig. 11) are very long and for the most part quite smooth. While the inner end always runs out into a point, they terminate externally in a double-toothed anchor, in which both teeth diverge almost transversely, are very gently curved, and end in a point. The shaft becomes gradually narrower to within a certain distance of the end of the anchor, and then increases in thickness on the anchor itself. The inferior margin of the whole anchor is a simple continuous arc, like that of *Pheronema giganteum* (Pl. XLV. fig. 9).

On young specimens I have sometimes seen small anchor forms buried in the body, and in these the shaft was, for the most part, beset with lateral barbs projecting towards the inner end.

6. *Pheronema giganteum*, n. sp. (Pls. XLV., XLVI.).

At the same station where the almost spherical specimens of *Pheronema globosum* were obtained, *i.e.*, near Little Ki Island (lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.), the trawl brought up from a depth of 129 fathoms and from a blue mud ground, a single well-preserved specimen of another *Pheronema* form. This is well figured in Pl. XLV. fig. 1, in half its natural size, and in Pl. XLVI. fig. 1, one-third reduced, in longitudinal section.

It differs from *Pheronema globosum* in its large size, to which it owes its title of *giganteum*, while as to shape it presents a long ovoid and somewhat obliquely depressed form, the peculiarity being due to a slight one-sided flattening from the side of the inferior pole. It measures 48 cm. in length and 20 cm. in maximum diameter, and exhibits an irregularly tuberculate surface. At the superior pole there is a circular terminal aperture, 6 cm. in width, and surrounded by a somewhat sharply angular projecting margin, enclosing the almost cylindrical gastral cavity, which is more than 20 cm. in depth.

From small boss-like (2 to 5 mm. broad) elevations of the external body surface,

which occur irregularly at intervals of 5 to 15 mm. over the whole skin, roundish tufts of radially disposed, pointed spicules, 3 to 6 cm. or more in length, project. From the somewhat protruding oscular margin, there projects a continuous, cuff-like, annular fringe of (3 to 4 cm.) long pointed spicules, with slight outward curvature. The whole downward directed surface, which is markedly enlarged by the above described oblique flattening of the sponge, bears a thick basal tuft, 10 cm. in length by 20 to 24 in breadth, and composed of much felted spicules. As in *Pheronema annæ*, *Pheronema carpenteri*, and *Pheronema globosum*, this tuft is composed of numerous individual and separate bundles of spicules, springing from the whole of the lower surface (Pl. XLVI. fig. 1). The external surface of the skin, as seen between the laterally projecting tufts of spicules, appears to the naked eye very uniform and even. Here and there, through the somewhat thick covering of the subdermal cavities, the afferent canal system may be recognised (Pl. XLVI. fig. 3). The internal lining of the gastral cavity, which is also formed from a firm uniform layer, is penetrated by groups of pores, with the exception of a somewhat protruding thick zone, 2 cm. in breadth, close beside the oscular margin. The groups of pores consist of three to five roundish exit openings of the efferent canals, and are covered by a delicate gastral network (Pl. XLVI. figs. 1, 4, 10, 11).

The wall of the sponge, which measures 4 to 6 cm. in thickness, is penetrated by roundish lacunæ and ducts of the afferent and efferent canal system, which, in their widest portions, especially below the dermal and gastral walls, attain a diameter of 10 mm. and more (Pl. XLVI. fig. 2). Between these wider passages there are tolerably thick (up to 10 mm. and more) tissue layers, which are penetrated by much narrower canals, opening laterally with narrow apertures into the larger (Pl. XLVI. fig. 2).

The spicules which belong especially to the parenchyma are of the following main types:—first of all, numerous strong pentacts, usually with a greater radial ray, while the four others do not always lie quite in one plane, and therefore not exactly at right angles to one another, but are slightly bent in various ways. It seems as if these parenchymal pentacts were originally hypogastralia and hypodermalia, which became secondarily involved in the parenchyma proper (Pl. XLVI. fig. 7). A second form of skeletal element, occurring abundantly in the parenchyma, represent the small oxyhexacts. The straight, regularly disposed, moderately strong rays of these forms are beset with somewhat distant, longer or shorter spines, projecting somewhat transversely (Pl. XLVI. fig. 8). In the third place, there are in the parenchyma, and in special abundance near the outer skin, uncinates of various length. The shorter forms, 0·6 to 1·0 mm. in length, are comparatively thick, and furnished with strong compressed barbs. They occur in irregular distribution throughout the parenchyma, while the longer forms, some mm. in length, project radially in bundles to the outer skin, or penetrating the latter, pass into the tufts of the pleural prostalia. On these long uncinates there are numerous barbs all round, longer and more slender than on the shorter forms, and further closely

appressed. They spring from a projection and cover over a groove-shaped depression. Finally, we have to note the occurrence (here and there very abundant) of small thin oxydiacts, which exhibit on their surface fine tubercles or spines, or only irregular roughnesses. It seems to me improbable that the amphidiscs found in the parenchyma really belong to it. I believe rather that they are present only by secondary dislocation, having originated in the dermal, gastral or canalicular skin.

The dermal skeleton includes strongly developed hypodermal oxypentacts of variable size. While the long proximal ray has usually a perfectly radial disposition, the four tangentials extending below the dermal membrane do not always form right angles with one another, and frequently exhibit near their origin a marked curvature to the side or inwards. The rays may exceed 1 mm. in diameter, and that strength is indeed common enough, though not at the point of origin, but at some distance up the ray. Between pentacts of this sort, tetracts occasionally occur, arising by reduction of the proximal radial ray. Not unfrequently, in some or in all, the ends are more or less markedly rounded. The autodermal pentact pinuli, present in great number and in strong development exhibit great variations in the size and form of the cypress-like or fir-tree-like free distal ray. The four cruciately disposed moderately long and thin basal rays lie in the same plane. Near their origin they are smooth, but bear on the larger outer end small teeth and spines. They usually end in a point, but in the larger specimens the ends are sometimes more or less bluntly rounded off (Pl. XLV. figs. 2, 3). The distal ray of the larger dermal pinules attains a length of 0·3 mm. and more. In form it resembles a slender cypress, so closely lie the uniformly long, oblique, lateral spines (Pl. XLV. fig. 2). Between these long pinules numerous smaller forms occur, which are usually much more slender, and run out into a single long terminal point (Pl. XLV. fig. 3). Less frequently compressed, broad and bushy forms occur (Pl. XLV. fig. 5). The tall cypress-like pinuli are usually associated with the strong tangential rays of the large hypodermal pentacts, while the slender and smaller forms occur on the sieve-like perforated dermal meshes, which are enclosed by large hypodermal pentacts.

The larger amphidiscs, which do not occur in what could be called abundance, attain a length of 0·18 mm., exhibit a moderately thin, tubercled, axial rod, and short campanulate, almost hemispherical terminal umbels, with eight smooth, terminally slightly pointed rays (Pl. XLV. fig. 8). Less frequently, somewhat broader ovoid amphidiscs occur, in which the umbel rays almost, or actually meet the opposites (Pl. XLV. fig. 7). Finally, a large number of small amphidiscs are found, with longish form, and almost hemispherical umbels composed of eight uniformly slender rays (Pl. XLVI. fig. 5).

The gastral skeleton exhibits the same strong and somewhat slimmer oxypentacts which occur under the external skin. The numerous pentact pinuli otherwise resemble the bushy forms of the outer skin, but have a much shorter bushy radial ray. On the sieve-network in the gastral skin, which covers the large grouped apertures, there are

delicate pinules with thin pointed basal rays, and with slender pointed free radial, as we have already described in the outer skin (Pl. XLVI. figs. 10, 11).

There is in the gastral skin a very abundant occurrence of large and long amphidiscs, with short, hemispherical, eight-rayed umbels, and tubercled, moderately slender, axial rods (Pl. XLVI. fig. 11), such as occurred sparsely in the dermal membrane. More abundant are the small, long amphidiscs, with slender, roughened axis rod, and short, hemispherical, eight-rayed terminal umbels.

The canalicular skeleton of the larger efferent passages differs essentially from that of the afferent ducts of the lacunar subdermal or subgastral spaces. Even macroscopic inspection of the internal surface of these canals and lacunæ, one notices a marked difference in the character of the surface, which is in the efferent canals quite rough and villous, while that of the afferent canals, and of the subdermal or subgastral lacunæ, appears comparatively smooth, or only exhibits a fine uniform roughness. On all the larger canals and lacunæ, the walls are supported by strongly developed hypocanalicular oxypentacts, with rays varying in strength, according to the size and width of the canals. Between the larger hypocanalaria, smaller forms always occur. The peculiarly rough nature of the afferent canals is conditioned by especially long, though not particularly broad autocanalicular pentact pinuli, in which the freely projecting cypress-like ray attains a length of 0·4 mm. and more. Of course between these long pinules shorter forms occur, with slender, slightly spinose, free radial rays (Pl. XLVI. fig. 6). Isolated amphidiscs of the larger sort and numerous representatives of the smaller type occur in the skin of the wider efferent canals (Pl. XLVI. fig. 6). Both the number and the size of the canalicular pinules and amphidiscs gradually decreases with the width of the canals, until they finally disappear in the neighbourhood of the chambers.

The lining layer of the large afferent canals and of the subdermal spaces is supported by smooth hypocanalicular oxypentacts entirely similar to those of the efferent canals. Both the autocanalicular pinuli and the amphidiscs are, however, entirely absent (Pl. XLVI. fig. 7, left).

The pleural prostalia, which project for 3 to 6 cm. from the lateral wall of the sponge, are strong smooth needles, which attain the thickness of a millimetre. They run to a point within the body, but the external termination unfortunately eluded distinct observation, since they were almost all broken off. Doubtless, however, they are either smoothly and simply pointed, or are terminally toothed, and end in a small five-pointed club. The same is true of the marginalia, which project for about 3 to 4 cm. I have already mentioned that numerous long uncinates with pointed external extremities project between the pleural prostalia.

The long basalia, which issue like the pleuralia in bundles, but become woven into a felted basal tuft, begin like the pleuralia and marginalia in an internal pointed end, swell out beyond the body into smooth cylindrical beams, which again decrease in thickness

towards the outer end, before which, however, they become again enlarged and end in a bidentate crescent-shaped anchor. The two teeth of the latter rise from the gently bow-shaped, rounded and thickened terminal portion (Pl. XLV. fig. 9), and end in simple conical points. The distance of these two terminal points, *i.e.*, the total breadth of the anchor, is about 0·5 mm.

Genus 3. *Poliopogon*, Wyville Thomson (Pls. XLVII.–L.).

Literature and History.—In his preliminary account of part of the Challenger Expedition[1] Wyville Thomson described a large sponge—*Poliopogon amadou*—which was found to the south of the Canary Islands at a depth of 1525 fathoms. This he regarded as type of a new genus—*Poliopogon.* This sponge forms an oblique and upward directed, semi-involute plate, with sharp upper and lateral margins, having the general shape of a tree fungus. From the transversely truncated base a strong beard of long siliceous fibres projects, and these fibres bear on their extremities two widely extended anchor teeth, which serve for fixing the sponge. An uniserial fringe of fine, straight, parallel, projecting siliceous spicules adorns the sharp free side and upper margins. The concave inner and the convex outer surfaces are covered by a fine network with quadrate meshes. "The sponge when brought up was of a delicate cream colour; it was necessary to steep it in fresh water to free it from salt, and the colour changed to a leaden grey."

Character of the Genus.—The body has the form either of a thick-walled goblet, or of an ear-shaped involute plate. It exhibits a broad basal tuft, and an oscular fringe of marginalia, but *no* laterally projecting pleuralia. The parenchyma contains small, extremely rough or spinose, oxyhexacts and uncinates, and in one species even small smooth oxydiacts of varying size and in varying abundance. The two teeth of the basal anchors are disposed approximately at right angles to the long, almost smooth shaft. The marginalia end externally in club-shaped thickenings.

1. *Poliopogon amadou*, n. sp. (Pls. XLIX., L.).

South-west from the Canary Islands (Station 3, lat. 25° 24′ N., long. 20° 14′ W.), from a depth of 1525 fathoms and hard ground, a beautiful *Poliopogon* form was dredged. This type, which was in 1877 figured and shortly described under the above title in Wyville Thomson's Atlantic, has not the cup shape characteristic of most other Hyalonematidæ, but exhibits rather the form of an ear, or that of a leaf rolled up into a semi-funnel (Pl. XLIX.). There is thus no gastral cavity but only a concave gastral, and a convex external surface, both of which are quite smooth, without radially projecting

[1] The Atlantic, vol. i. p. 174–176.

spicules from the delicate quadrate meshwork, and are distinctly marked off from one another by a somewhat sharp-edged, spicule-bearing border, extending down to the bushy basal portion. Towards the external margin, the flat body which measures 3 to 5 cm. in thickness, becomes gradually sharper; the maximum height is 40 cm., and the breadth about as much. The somewhat irregular knobbed base is continued into a bushy beard-like basal tuft of spicules 10 to 12 cm. in length. By this the sponge is fixed among the coral and other detritus (Pl. XLIX.).

The parenchymal skeleton consists of large or medium-sized smooth oxypentacts, which probably had their four tangential rays originally inserted in some bounding surface, while the fifth stood radially. Afterwards, however, they came to be embedded in the parenchyma. The angles of the five rays are generally, though by no means always, right angles, and one or other of the rays not unfrequently exhibits a simple curvature near its origin. The individual rays usually have a length of 10 to 20 mm. Throughout the whole parenchyma irregularly scattered, small, lank oxyhexacts also occur, with rays of about equal length, straight or slightly curved, and usually somewhat roughened, *i.e.*, beset with small pointed tubercles, which are occasionally longer, and project obliquely outwards, as represented in Pl. L. fig. 6. Less frequently uncinate forms occur, but only near the two limiting surfaces, and usually in radial disposition. Some uncinates only attain a length of 2 to 4 mm. (Pl. L. fig. 3), but most are much longer. The short, smooth, spindle-shaped oxydiacts, which occur so abundantly in the parenchyma of *Poliopogon gigas*, to be described below (Pl. XLVIII. figs. 3, 7), are here wholly absent.

The supporting spicules of the gastral skeleton are, as in all Hyalonematids, strongly developed, smooth oxypentacts of varied dimensions. Their radially directed ray may attain a length of 1 to 2 cm., while the four tangentials, crossed approximately or exactly at right angles, and but rarely bent, may be as long or longer, and are apposed to one another in twos or threes to form the familiar quadratic lattice-work. The autodermal pinuli are somewhat small pentacts about 0·4 mm. in length, with straight spines directed obliquely upwards and outwards. The outer end of the distal ray passes into a long thin point; the basal portion is smooth. The four moderately long (0·1 mm.) basal rays, are internally smooth, but are on their outer halves beset with short, distant, outward directed teeth, and end in slightly conical points. While disposed at right angles to the distal ray, they do not form right angles with one another, but two opposite obtuse and acute angles, with a slight curvature in the two acute angles so that the form of the central portion of a 8 results (Pl. L. fig. 5). Numerous eight-rayed amphidiscs of various size, but of similar form occur in the dermal membrane, and appear to penetrate thence into the parenchyma. The larger have the middle portion of their axis rod inserted in the dermal membrane, while the one end projects freely to the exterior, and the other into a subdermal space. Some of these have a length of 0·2 mm. and a moderate thickness, are

tolerably smooth, exhibiting four to eight protruding bosses on the middle of the axis rod, and bear bell-shaped umbels with somewhat divergent rays of a flat paddle-like form (Pl. L. fig. 8). Others, measuring 0·1 mm., have a thinner, knotted axis rod, and umbel rays with somewhat pointed ends, while small forms also occur, measuring 0·06 to 0·04 or even 0·03 mm. in length (Pl. L. figs. 10, 11, 12).

Very similarly constituted are the spicules which form the skeleton of the other, or gastral side of the curved body. Here also the same oxypentacts occur as hypogastralia, the same pentact pinuli as autogastralia, and amphidiscs of similar form and equally varied dimensions (Pl. L. fig. 1).

In the lateral wall of the larger efferent canals there are also oxypentacts similar to the hypodermal and hypogastral forms, though less strongly developed and less long. Pinuli, however, are absent, but the very abundant amphidiscs exhibit the same size and form as those of the skin.

The long lank marginalia which form the marginal fringe round the edge of the whole sponge, usually measure some mm. (up to 1 cm. or more) in length. They are for the most part quite smooth, form internally a long thin point, while externally they bear small, somewhat distant lateral teeth, which project obliquely upwards and outwards. They finally end externally in a slight club-shaped or bud-like swelling (Pl. L. figs. 1, 4). The long strongly developed spicules (5 to 10 cm. in length), which project like a beard from the thickened lower portion of the sponge body into the mud, are quite smooth. They end internally, *i.e.*, in the sponge body, in a simple point, while towards the lower outer free end they first decrease gradually in thickness, and then again slowly increase, finally forming a double toothed very gently curved anchor. The two teeth of the latter stand out almost at right angles from the shaft, are only slightly bent, and end in a somewhat blunt point (Pl. L. fig. 7).

It is especially interesting to note that in the larger cavities of one of the specimens of *Poliopogon amadou* some small, approximately spherical sponges were found, measuring about 3 mm. in diameter, and undoubtedly young forms of *Poliopogon*. Since their tissue was still in tolerable preservation, it was possible to make sections through the small bodies. These results were important not only for the species but for the whole genus, and indeed for the family of Hyalonematidæ.

I have given in Pl. L. fig. 2 a diagrammatic representation of the structure exhibited in successful axial sections of the young sponge forms. The characters more or less distinctly prominent on various sections have been combined in a synthetic figure. A central cavity with which all the diverticula of the folded chamber-layer directly communicate, opens to the exterior at the upper pole of the somewhat transversely oval section. This external aperture is not, however, completely free and open, but seems still to be covered by a delicate membrane. The *membrana reticularis* which forms the chamber-like diverticula, is perfectly continuous, forming a much folded and puckered

membrane, the diverticula of which all project outwards against the smooth distended outer skin. On the inner side of the larger diverticula, a delicate network extends, while outside of the reticularis, between it and the reticulate dermal membrane, there is the external trabecular network.

The external layer of the dermal membrane is supported by smooth simple, hypodermal oxypentacts, with four tangential rays, intersecting parallel to the surface and somewhat curved, while the proximal ray, at right angles to the latter, is inserted radially in the parenchyma. Long slim spicules project radially on all sides for a greater or less distance from the sponge body. They are either simply pointed at both ends, and thus in part to be described as incipient uncinates, or exhibit on the freely projecting portion minute teeth or spines directed obliquely outwards, and on the outer end a slight club-shaped toothed swelling with a narrow terminal point, while the internal proximal portion remains smooth. Both in the external skin and in the parenchyma there are numerous amphidiscs of the same form and size as those in the adult *Poliopogon amadou.* On the lining of the gastral central cavity similar forms occur, which have been overlooked in the figure (Pl. L. fig. 2). At the inferior pole, opposite the oscular opening, the anchor forms above mentioned occur, in part buried in the parenchyma, in part more or less protruded. They resemble those of the adult but are of much smaller size. It is striking that the parenchyma is wholly destitute of the *small hexacts* and of the *pinuli* on the external and internal sides of the bounding surface.

2. *Poliopogon gigas*, n. sp. (Pls. XLVII., XLVIII.).

An immense sponge form, which turned out to be a *Poliopogon*, was trawled between the Raoul and Macaulay Islands, to the north of New Zealand, (Station 170, lat. 29° 45′ S., long. 178° 11′ W.) at a depth of 630 fathoms, from a volcanic ground. The roundish cubical mass has a diameter of 50 to 70 cm. The lower wholly torn surface still exhibits the remains of bundles of spicules, which have undoubtedly formed, along with others now lost, a thick broad basal tuft. The lateral rounded external surface is tolerably smooth, without projecting bundles of spicules or isolated radial prostalia, and covered by an incompletely preserved fine quadratic dermal lattice-work. The upper much injured terminal surface bears a median hemispherical depression, from 15 to 20 cm. in breadth and the same in depth, representing the gastral cavity (Pl. XLVII.). The marginal fringe of the oscular aperture is unfortunately not preserved.

The spicules of the parenchyma, which is penetrated by lacunæ and canals of varying width, essentially resemble those of *Poliopogon amadou.* Here too we find smooth oxypentacts of variable size, with long straight or slightly curved rays. The original disposition of these pentacts seems to have been not so much in the parenchyma, as in the external or internal limiting membrane or in the walls of the larger canals. Small

oxyhexacts with slightly curved slender rays occur, similar to those which were found so abundantly in the former species (Pl. XLVIII. figs. 1, 10). In certain regions, for instance somewhat abundantly below the outer skin, a skeletal element, not represented in *Poliopogon amadou*, occurs—in the form of small spindle-shaped smooth oxydiacts, (0·15 to 0·25 mm. in length) which have a maximum thickness either in the neighbourhood of their centre (Pl. XLVIII. fig. 3) or more rarely nearer one end (Pl. XLVIII. fig. 7). Here and there, especially in the neighbourhood of the external surface, long uncinates occur, with narrow appressed pointed barbs covering minute depressions. I have not been able to determine whether the amphidiscs of varied form and size, which occur scattered in great abundance in the parenchyma (Pl. XLVIII. fig. 1), are really true parenchymalia, or have grown in from the bounding surfaces of the external skin, of the gastral cavity, or of the canals.

The dermal skeleton consists of rather strongly developed smooth oxypentacts. The autodermal pinules are indeed for the most part pentacts, but others not unfrequently occur, in which the sixth proximal radial ray is more or less distinctly developed (Pl. XLVIII. figs. 8, 11). The four basal rays of the ordinary pentact pinules are somewhat long, and bear externally short spines projecting obliquely outwards, while the extreme outer end is rounded off or even truncated, though rarely pointed. As a rule the basal rays are like those of the dermal pinuli in *Poliopogon amadou*, bent like the middle portion of a figure 8 (Pl. XLVIII. figs. 5, 9). The freely projecting, radial distal ray is not so long and slender as in *Poliopogon amadou*, but rather broad and only about 0·15 mm. in length. It is beset with lateral spines, which are curved somewhat markedly outwards, and terminally apposed in bud-like fashion. Less frequently the distal ray ends in a point (Pl. XLVIII. fig. 5). The large amphidiscs lying in the dermal membrane have a length of about 0·2 mm. Their axial rod is somewhat uniformly beset with small tubercles. The campanulate umbels have usually eight, less frequently more rays, which are of considerable length, often almost meeting, and but slightly divergent (Pl. XLVIII. fig. 2). Besides these, there is an abundant occurrence of small amphidiscs with short, hemispherical, eight-rayed terminal umbels and slender axial rod (Pl. XLVIII. figs. 4, 6).

Whether the gastral skeleton surrounding the cavity closely resembles the dermal I was unable certainly to determine, owing to the want of sufficient material from that portion of the giant sponge. It is, however, extremely probable, from analogy with the related species of *Poliopogon amadou*, that the structure of the canalicular skeleton lining the larger ducts and lacunæ essentially resembles that of the skin. Pinules are not wholly absent, but occur as slender, scattered, canalicular pentacts or hexacts, with long, narrow, pointed basal rays, and a slender free radial, which ends in a delicate point, and bears isolated, short, straight, obliquely projecting lateral spines. In the larger ducts and lacunæ, numerous large and small amphidiscs occur of the form described in the

dermal skeleton. No marginalia are preserved. In the thick beard-like shreds which here and there still project from the base, numerous anchors occur, of the same form as those of *Poliopogon amadou*, with a shaft which may measure 10 cm. or more, while the slightly forward-curved ends of the two transverse teeth are separated from one another by about 0·5 mm. (Pl. XLVIII. fig. 14, *a*). The pointed upper end of the anchor shaft, which is buried in the sponge body, frequently bears several short, scattered, downward-directed, lateral barbs (Pl. XLVIII. fig. 14, *b*). In Pl. XLVIII. fig. 13, I have figured a remarkable abnormal form of anchor structure.

Subfamily 2. SEMPERELLINÆ, F. E. Schulze.

Genus *Semperella*, Gray (Pls. LI., LII.).

1868. Semper, Verhandl. der Würzb. Gesellsch., vol. i. p. 29 (*Hyalonema schultzei*).
1868. Gray, Ann. and Mag. Nat. Hist., vol. ii. p. 373 (*Semperella*).
1868. Herklots and Marshall, Arch. Neerland. d. sc. nat., iii. p. 435 (*Hyalothauma ludekingii*).
1872. Carter, Ann. and Mag. Nat. Hist., vol. x. p. 110.
1872. Gray, Ann. and Mag. Nat. Hist., vol. x. p. 134.
1872. Gray, Ann. and Mag. Nat. Hist., vol. x. p. 76 (*Meyerina claviformis*).
1873. Carter, Ann. and Mag. Nat. Hist., vol. xi. p. 275.
1873. Carter, Ann. and Mag. Nat. Hist., vol. xii. p. 349.
1874. Gray, Ann. and Mag. Nat. Hist., vol. xiii. p. 284.
1875. Carter, Ann. and Mag. Nat. Hist., vol. xvi. p. 200.
1875. Marshall, Zeitschr. f. wiss. Zool., Suppl., Bd. xxv.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii.
1877. Miers, Journ. Linn. Soc. Lond. (Zool.), vol. xiii. p. 506.

History.—In 1868 Semper described under the title *Hyalonema schultzei* a Philippine sponge, resembling in size and form *Euplectella aspergillum*.[1] Semper's preliminary note was to the following effect:—"*Hyalonema Schultzei*, S. resembles in form and size *Euplectella aspergillum*. The root-fibres, which are either smooth or serrate, divide towards the sponge body into single bundles. They traverse the latter both internally and superficially, becoming connected with the main framework in the same way as do the long root fibres of *Euplectella*. Cruciate spicules of many kinds are united with these long strands of fibres, forming sometimes a very dense and sometimes a loose network, which is penetrated in all directions by the large canals of the sponge. The comparatively wide excurrent appertures occur irregularly over the whole sponge, and are frequently associated with tufts of fine, almost silk-like fibres. On several regions of the somewhat injured surface, a fine network with wide rectangular meshes may be observed. The whole sponge framework is, as in all true *Hyalonemata*, composed of free fibres or

[1] *Verhandl. phys.-med. Gesellsch. Würzburg*, vol. i. p. 29, 1868.

cruciate spicules. Sometimes, however, several spicules are fused together, and the origin of the connected siliceous framework of *Euplectella* is thus suggested. The shapes of the numerous free siliceous bodies recall those of *Hyalonema sieboldii*, Gray, from Japan."

In the same year (1868) Gray proposed to designate those sponges, which were in every way so different from the known species of *Hyalonema*, by the new generic title *Semperella*.[1] Moreover, to a specimen of the same species from the island of Ceram the name *Hyalothauma ludekingi* was given by Marshall and Herklots. Another sponge belonging to the same species, was sent from the Philippine Island of Zebu through Dr. A. Meyer to the British Museum, and was shortly described by Gray in 1872,[2] under the title *Meyerella claviformis*. Carter gave a detailed analysis of the same specimen,[3] and he changed the generic name *Meyerella* which had been given by Gray, into *Meyerina* because the former had already been applied to one of the *Lepidoptera*. In regard to the forms of the spicules, Carter regarded the new species as a combination of *Carteria*, *Hyalonema*, *Holtenia* and *Pheronema*.

Gray now erected [4] for this sponge a special family—the Meyerinidæ—and characterised it in the following manner:—" Sponge elongate, tubular, covered with a cobweb-like netted coat, with a circle of tufts of anchoring fibres at the base which extend more than half way through the length of the body, and then by repetition of a shorter kind, are continued on to the apex, where they also form a circle of tufts round the margin of the apical aperture."

In his first systematic catalogue of the known Hexactinellida Carter[5] united *Meyerina claviformis*, Gray, with *Holtenia* and *Pheronema* into one group. On pl. xiv. he has compared the extremities of the tuft spicules, which are very like the anchors of *Holtenia* and *Meyerina*.

In his Classification of the Spongidæ, published in 1875,[6] Carter formed the group of "*Birotulifera*" in the family of the Sarcohexactinellida, of the genera *Hyalonema*, *Holtenia*, *Meyerina* and *Labaria*.

The specific agreement of the variously designated forms was first recognised by Marshall, who, in his researches in the Hexactinellida[7] in 1875, pointed out that, with exception of the generic name *Hyalonema* used by Semper, the oldest designation is that of *Semperella schultzei*, and that this name is therefore entitled to be retained as the proper one. In his accurate and careful description of the two specimens at his command—one of which was found at Ceram and the other at Zebu—Marshall pointed

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ii. pp. 373–377.
[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. x. p. 76, 1872.
[3] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. x. p. 110, 1872.
[4] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. x. p. 134
[5] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 162, 1873.
[6] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xvi. pp. 199, 120.
[7] *Zeitschr. f. wiss. Zool.*, Bd. xxv., Suppl., pp. 212–225.

out that the dense sieve-plate openings which occur abundantly on the truncated lateral borders of the five-sided prismatic body, and are surrounded by delicate spicules projecting in a cuff-like manner, are the oscular openings of the main anastomosing canal system running longitudinally in the walls of the sponge. The larger hollow spaces occurring in the axis and opening above he designated *pseudogasters*, and their terminal latticework closing plates as *pseudo-sieve-plates.* A second system of passages and canals, which lie between these exhalent oscular openings, separated from them by sponge tissue, and covered towards the outside by fine dermal lattice-like networks were referred by Marshall to the *subdermal* spaces of Haeckel, or to the *intermarginal* cavities of Bowerbank. In consequence of these results of his examination, Marshall,[1] in 1876, characterised the genus *Semperella* in the following manner:—"Polyzoic with pseudogasters. Anchor bundles anastomosing with each other throughout the whole body wall. Dermal skeleton of cross spicules separated by the tissue of the body and spread over large subdermal longitudinal spaces into which the internal canals open. Oscula of the individuals in rows, with peristome wreath and sieve-plate. The gastral skeleton formed of large four-rayed spicules, provided with meshes occlusible by means of fir-tree-like spicules, and in direct connection with the dermal skeleton. The cavities of the pseudogastral system are covered internally by six- and five-rayed spicules."

Semperella schultzei, Semper.

Near the Philippine Island, Zebu, the Challenger Expedition obtained a beautiful specimen of *Semperella schultzei*, 38 cm. in length, and 5 to 7 in thickness. This form having been well preserved in spirit, remains almost uninjured. The cylindrical body, which measures 30 cm. in length exclusive of the basal tuft, has inferiorly a cylindrical form, but becomes gradually wider upwards, forming an irregular pentagonal prism with truncated edges. The latter are from 5 to 8 mm. in breadth, and from the middle of the body upwards do not extend in exact longitudinal direction, but extend on the one hand obliquely, and further divide and anastomose, till they finally unite in the superior flat cone, which occupies the terminal region of the upper end. The root-process, which extends perpendicularly downwards from the lower end of the sponge, becomes widened out inferiorly into a loose brush, and penetrates by means of its diverging spicules into the very varied detritus-substratum. There was no trace of commensal *Anthozoa*.

It is noticeable, even with the unaided eye, that a striking difference can be observed in the structure of the external layer of skin on the above mentioned truncated lateral edges, and that on the intervening flat, or even slightly concave, lateral surfaces (10 to 30 mm. in breadth). For while the latter exhibit a very delicate narrow-meshed quadratic

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxvii. p. 131.

lattice-work, with meshes which do not attain a width of a ½ mm., and are separated by yet thinner strands, the skin on the rib-like projecting truncate edges exhibits a much more irregular network with polygonal or roundish meshes, 1 to 2 mm. in diameter, and with firm whitish strands passing laterally into a compact marginal fringe about 1·5 to 2 mm. in breadth, which forms the boundary between the narrow-meshed quadratic network of the sides, and the wide-meshed firmer sieve-network of the rib-like edges (Pl. LI. figs. 1, 16). Through both these networks, which differ so much from one another, the subjacent cavities are seen, shining through as a labyrinth of united passages. On the superior, somewhat obliquely pyramidal or flatly conical, truncate extremity of the sponge, the wider network, strengthened by firm solid junction-plates, is terminally expanded and united, while the fine quadratic dermal lattice-work is confined to the sides, with the exception of several angular or rounded terminal prolongations, which extend beyond the lateral terminal margin on to the summit. Where some of this lateral dermal sheath has been rubbed off by accident or design, the labyrinthine passages and spaces are directly exposed, and it can be seen how the canals and cavities beneath the narrow quadratic dermal network form a connected, continuously distinct anastomosing system of canals, a little finger's breadth thick, which are separated by a wall of 1 mm. thickness from another adjacent canal system, which likewise forms a connected network of anastomosing spaces and passages. This second system of passages extends directly under the wide-meshed, more irregular lattice-work, which we have noted on the rounded off lateral edges. The two canal-systems are everywhere separated only by a thin partition, and their canals extend side by side, not only under the external skin, but penetrating inwards, traverse the whole internal body, so that the broad, irregular, longitudinal canal in the axial region is an integral part of that system of passages, which extends below the wider irregular network of rounded side margins, and which opens at the superior terminal plate. This remarkable presence of two completely separated canal systems is represented in Pl. LI. fig. 16, in the lateral portion of the sponge from which the external wall has been partly removed, and also in the diagrammatic cross section of the whole sponge in Pl. LII. fig. 1.

Through the fine quadratic dermal network which covers the slightly convex lateral surfaces of the body, the water passes first into the subjacent canal system, by which it is carried to all parts of the body, penetrating at length through the partition wall (which, though only about 1 mm. thick, contains the *membrana reticularis* and forms the proper parenchyma) into the second system of canals which is in connection with the central longitudinal canal or gastral cavity. Thence the water reaches the exterior by the efferent ducts, namely, either by the wide-meshed oscular sieve-network of the longitudinal side edges, or by the superior terminal region.

That the relation of these two adjacent, but perfectly distinct, labyrinthine canal systems to the flow of water is as above described, is demonstrable not only from their

relation in reference to the skin, or from the connection between the second and the main central canals, but also from the structure of the soft sponge body, and especially from the form and disposition of the chamber layer, or more correctly of the system of irregular diverticula from the *membrana reticularis*. As in all Hyalonematidæ the latter extends in the parenchyma between afferent and efferent canal-system in such a way, that the convexity of all the diverticula is directed outwards against the entering stream of water, that is, against the afferent system of canals. Every longitudinal or transverse section of the sponge body shows that the *membrana reticularis* found in the partition between the two systems is so disposed or manifoldly bent outwards, that the convexity of each small protrusion is against the processes of those canals which lie under the fine-meshed quadratic dermal network on the flat or slightly convex sides (Pl. LII. fig. 3).

The canals below the dermal membrane, which extends in the form of the fine-meshed quadratic network, represent wide subdermal spaces, and those penetrating inwards are somewhat uniformly wide afferent canals which do not break up into branches, but form an anastomosing labyrinth (Pl. LII. fig. 1).

Large supporting spicules are represented in the parenchyma by a few medium-sized oxyhexacts, and by numerous oxypentacts, some of them with very long rays. Long uncinate spicules also occur (Pl. LI. fig. 3), disposed in brush-like strands or groups, at right angles to the skin, where the parenchymal canal-wall is inserted on the external skin. Besides these, we note smaller spicules of the following types:—Firstly, small oxyhexacts with slim rays of equal or diverse length, beset to a variable extent with somewhat distant, straight or slightly curved spines, which are inserted either at right angles or approximately so (Pl. LI. fig. 15; Pl. LII. fig. 5); secondly, oxydiacts of a similarly spinose character, and with four short, smooth, conical median rays or spines intersecting at right angles, and representing the survival of the other four degenerate rays of the hexacts (Pl. LII. fig. 4); and thirdly, isolated short uncinates with small short barbs (Pl. LI. fig. 6).

The dermal skeleton, which supports the fine-meshed quadratic lattice-work, consists of very varied, strongly developed, hypodermal oxypentacts, with long smooth tangential rays, which are often somewhat strongly curved at the base, though sometimes but slightly developed, and which are apposed to one another to form the quadratic lattice-work, while the more or less long, straight, proximal tangential ray, extends to a variable distance inwards, and often projects freely into the hypodermal canal (Pl. LII. fig. 3). Only where the internal wall of the canal is connected with the skin does the tangential ray lie throughout its whole—often considerable—length in the parenchyma. On the tangential strands of hypodermalia, and on the bands of the dermal network extending between the former, autodermal pentact pinuli occur, usually disposed in rows. The four thick and moderately long, externally spinose, terminally somewhat conical or rounded basal

rays of these pinuli exhibit a median curvature like that of the figure 8, as we formerly saw in the dermal pentact pinuli of *Poliopogon.* The free strongly developed distal ray has usually a length of about 0·15 mm., and is beset with strong, though not long, lateral spines bent like hooks upwards and outwards. The very upper end forms a free point (Pl. LI. figs. 5, 13).

As to amphidiscs, I find a large isolated form about 0·25 mm. long, with thick knotted axial rod, and short, broad, terminally somewhat transversely truncate umbels. The eight broad rays are paddle-like and terminally rounded (Pl. LI. fig. 10). Beside these, though also but sparsely, a similar form of medium-size occurs (Pl. LI. fig. 8), and somewhat more abundantly the familiar small type with hemispherical terminal umbels, 0·02 to 0·03 mm. in length (Pl. LII. fig. 7). More frequent than in the stretched, freely exposed, dermal lattice-work, is the occurrence of these various amphidiscs in the portions of the skin which lie over the insertion of the parenchymatous canalicular wall (Pl. LII. fig. 3).

The same kinds of spicules, but with somewhat different development and dimensions, compose the skeleton which forms the wide-meshed sieve-network in the oscular regions of the bevelled sides and of the superior extremity of the whole sponge body. The large supporting pentacts exhibit indeed the same fundamental form and dimensions as those of the dermal membrane, but reductions of individual rays very frequently occur, with the production of rounded ends, or with the formation of slight, terminal, club-shaped swellings. The downward curvature at right angles, exhibited by some of the tangential rays, is also of very common occurrence. Especially remarkable, however, is the considerable length attained by the free distal ray of the pinuli. As a rule, this thick ray, beset with short hook-like lateral spines, measures 0·5 mm. in length, and ends in a projecting point. The four basal rays are moderately long, less curved, and terminally somewhat spinose and rounded (Pl. LI. fig. 4). Besides these, shorter pinuli occur with slimmer distal ray. The strong eight-rayed amphidiscs (figured in Pl. LI. fig. 10) occur here more abundantly than in the dermal lattice-work, and always exhibit in successful preparations the characteristic disposition represented in Pl. LII. fig. 3. Numerous eight-rayed amphidiscs of similar form, but of medium size occur, and also quite minute forms with hemispherical umbels.

It is noteworthy that neither pinuli nor amphidiscs occur on either of the bounding surfaces of the parenchymatous septa between the afferent and efferent canals, but only the familiar parenchymalia, including numerous medium-sized oxypentacts, with numerous bent, or with more or less reduced rays. I have, however, frequently found—instead of the familiar small oxypentacts with several laterally projecting, somewhat bent spines,—pentacts of similar structure, in which the sixth ray was either wholly absent, or represented only by a small conical elevation.

The freely projecting portion of the basal tuft exhibits spicules up to 20 cm. in length, which terminate superiorly in a very gradual point, while the lower end forms a strongly

developed bifurcate anchor. The simple tooth- or paddle-shaped transverse arms of the latter exhibit a much thickened base rising from the club-shaped swollen terminal portion, and in the larger forms are connected by a distinct lateral fringe on either side. While the upper half of the long anchor spicules, which is for the most part buried in the sponge body, is perfectly smooth, gradually increasing in thickness downwards, the lower half, which becomes gradually narrower, bears small barbs increasing in height and breadth. These are spirally disposed round the shaft, and decrease again in size towards the very end, disappearing entirely a little above the anchor. Thus the much narrowed, and just above the anchor yet slimmer, terminal portion appears quite smooth (Pl. LI. fig. 14).

Among the many Hexactinellids which were trawled by the Challenger near the Little Ki Islands (Station 192, lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.), from a depth of 192 fathoms and a blue mud ground, there was a beautiful specimen of a *Semperella*, which agrees in so many points with *Semperella schultzei*, Semper, that I regard it as a young form of the latter. There are indeed some differences, but these may be explained as characteristic of the young form. The specimen has a total length of 10·5 cm., of which only 5·6 go to the stretched cylindrical body, and 4·9 cm. to the inferiorly much broadened root process, which is almost wholly enveloped in a *Palythoa* encrustation (Pl. LII. fig. 2). At its broadest the body measures 12 mm., and the somewhat bevelled longitudinal edges, which measure about 2 mm. in breadth, anastomose abundantly by means of cross processes. They project somewhat more markedly than in the adult specimen, and are bounded by a fringe of perpendicularly inserted, straight, rod-like spicules (Pl. LII. fig. 3), which may be called marginalia, and are almost wholly absent in the large specimen. These slim spicules, which in many places form a continuous garniture and in others are not discoverable, are quite smooth on their internal pointed half, while the free external portion is for the most part beset with small lateral teeth (turned upwards and outwards), and ends in a delicate point, below which there is usually a small club-shaped swelling with two or four lateral teeth. Similar needles also project in the above described young specimens of *Poliopogon amadou*, both on the oscular margin and on the lateral surface, but are not discoverable on the side of the adult form. This fact seems to make it especially probable that we have here to do with a young specimen, and not with another species, and that the more, since all the other spicules closely resemble in form and disposition those of the larger specimen, as is equally true of the structure of the soft tissue.

Suborder II. DICTYONINA, Zittel (Pls. LXXI.–CI., CIII., CIV.).

Hexactinellida in which the principal hexacts are already at an early stage united into a connected and compact (dictyonal) framework in a more or less regular fashion.

Tribe I. UNCINATARIA, F. E. Schulze (Pls. LXXI.–XCVIII.).

Dictyonina with uncinates.

Subtribe I. **Clavularia,** F. E. Schulze (Pls. LXXI.–LXXVI.).

Besides the pentact hypodermalia and hypogastralia radially disposed clavulæ occur.

Family FARREIDÆ (Pls. LXXI.–LXXVI.).

The dictyonal framework forms in the youngest regions of the body a single-layered network with quadrate meshes, from the nodes of which conical protuberances project on either side towards the dermal and gastral surfaces.

Genus *Farrea*, Bowerbank (Pls. LXXI.–LXXVI.).

1857. Owen, Trans. Linn. Soc. Lond., vol. xxiii., pl. xxi. figs. 8, 9.
1862. Bowerbank, Phil. Trans., vol. clii. p. 747, Tab. xxxii. fig. 7.
1864. Bowerbank, Mon. Brit. Spong., Bd. i. p. 204.
1864. Kölliker, Icones histologicæ.
1867. Gray, Proc. Zool. Soc. Lond., p. 492, Tabs. xxvii., xxviii.
1868. Bowerbank, Proc. Zool. Soc. Lond., p. 118.
1869. Bowerbank, Proc. Zool. Soc. Lond., p. 66.
1869. Wyville-Thomson, Phil. Trans., vol. clix. p. 701.
1870. O. Schmidt, Grundzüge einer Spongienfauna des atlantischen Gebietes, p. 16.
1870. Saville Kent, Monthly Micr. Journ., p. 241.
1873. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xii. pp. 17, 349.
1875. Bowerbank, Proc. Zool. Soc. Lond., p. 272.
1875. Marshall, Zeitschr. f. wiss. Zool., Suppl., Bd. xxv. p. 142.
1876. Bowerbank, Proc. Zool. Soc. Lond., p. 535.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii. p. 113.
1877. Sollas, Ann. and Mag. Nat. Hist., ser. 4, vol. xix. p. 1.
1880. O. Schmidt, Spongien des Meerbusens von Mexico, p. 43.
1885. Carter, Ann. and Mag. Nat. Hist., ser. 5, vol. xv. p. 387.

History.—In the root-tuft of that beautiful siliceous sponge which was on one occasion presented to Captain Etheridge by the king of the Seychelles, and which, after it passed into the possession of Dr. Arthur Farre, was accurately studied by Richard Owen, and described under the name of *Euplectella cucumer*,[1] fragments of the siliceous skeletons of other sponges were entangled. Some of these skeletal fragments, which had already been observed by Dr. Farre, were subjected by Owen, along with the *Euplectella*, to a closer examination, and he even figured two of them, both in the natural size and

[1] *Trans. Linn. Soc. Lond.*, vol. xxiii., pl. xxi., 1857.

also under a magnifying power of ten and twenty diameters, in his pl. xxi. figs. 8, 9. In the course of his paper he describes the one piece in the following words:—"An irregular network, more or less bent, with subquadrate meshes, sometimes crossed by oblique threads," while, with regard to the other he said:—"The meshes of the network are on nearly the same plane, and of a more regular square form, with a short pointed spiculum projecting from one side of each decussation of the threads like the teeth of a harrow."

Some years later Bowerbank also communicated the results of his examination of the same object. He considered the two skeletal fragments which had been described and separated by Owen to be parts of one and the same sponge. The harrow-like network of siliceous beams represented by Owen in his figs. 8 and 9, with its regular quadrate meshes and pointed teeth projecting perpendicularly from the crossing points, he regarded as the *dermal skeleton*, under which only the irregularly formed inner body skeleton was said to have lain. After more precise examination of both parts by the aid of stronger magnifying powers, Bowerbank saw that the beams of the fragment regarded by him as belonging to the inner body skeleton were completely perforated by a manifest axial canal, and were richly covered externally with fine spines, while the beams of the (dermal) skeletal network which formed quadrate meshes appeared solid and smooth. Only the teeth projecting at right angles to the knob points appeared rough. Bowerbank, moreover, drew attention to the fact that the rough teeth stand at right angles to the plane of that quadrate network not only on its outer side, but on both surfaces.

To this form, the body and dermal skeletons of which he had examined in the above two fragments, Bowerbank gave the generic designation *Farrea*, in honour of the fortunate possessor of that specimen of *Euplectella cucumer* in whose root-tuft the forms were found, and he added to this the specific name of *occa* on account of the great similarity of one of the specimens to a harrow.[1] In his Monograph of the British Spongiadæ (part i. p. 204, 1864), Bowerbank referred his *Farrea occa* to the sponges with a "canaliculated siliceo-fibrous reticulate symmetrical skeleton," the "fibres" of which being "composed of concentric layers of solid silex, with a continuous central canal," and he added:—"The fibres in *Farrea occa* are rather coarse, abundantly tuberculated, and the mode of reticulation is rectangular." The inner body skeleton referred to in this latter description is figured in pl. xv. fig. 277, and in the description of the plate is referred to as "simple fistulose siliceous fibre, spinulated"; while the solid and smooth network of beams which, in Bowerbank's opinion, belongs to this sponge and constitutes its dermal skeleton, is figured on pl. xxi. fig. 311, and in the description of the plate is referred to as a "quadrilateral siliceo-fibrous network showing the double series of entirely spined spicular organs projected from its angles."

[1] Lat., *occa*.

Finally Bowerbank again gave, in 1869,[1] a more minute description of his *Farrea occa*, and supplied three new figures on pl. xxiv. figs. 1, 7. In this latter very detailed communication the siliceous network with its quadrate meshes, regarded as dermal skeleton and compared in form to a harrow, is represented by Bowerbank just as formerly; on the other hand, in addition to the more irregular and rough network of beams regarded as belonging to the inner framework, a number of variously formed isolated siliceous spicules are figured and described as accessory parts of the skeleton. These have four, five, or more rays, and do not present the right angles of the Hexactinellidan spicules. The generic characters of *Farrea* were summarised by Bowerbank in the same paper (p. 76) in the following manner:—"Skeleton siliceo-fibrous. Fibres canaliculated, canals continuous. Rete symmetrical; interstices rectangulated." The view first announced in the well-known paper by Wyville Thomson On the Vitreous Sponges,[2] is noteworthy; it is to the effect that the framework of beams which in the skeleton of *Farrea* forms a system with exactly square meshes has arisen by an amalgamation of regular hexradiate spicules.

Among the deep-sea sponges collected by Count Pourtalés in the Caribbean Sea Oscar Schmidt found in 1870[3] several irregular dichotomously branched tubes from 2 to 6 mm. in diameter. These were attached by a plate-like expansion, were thick-walled at the base, and became towards the wide open upper extremity gradually thin-walled and fragile, till finally on the outermost and doubtless youngest parts of the little tubular tree only a single layered network of siliceous beams and square meshes was found. From the intersections of the latter rough slender conical teeth projected on both sides. In addition to this siliceous network, which, in its youngest parts at least, presents a certain resemblance to the harrow-like siliceous network of beams of *Farrea occa* which Bowerbank regarded as a dermal skeleton, Oscar Schmidt also found and described the following free siliceous spicules:—(1) long spindle-spicules beset with barbs; (2) long spicules which run out at one extremity to a point, and are provided on the other with a hemispherical or slightly convex and marginally toothed umbel-like roof or cap; (3) hexradiate spicules, in which each of the rays is beset on its extremity with three pronged, thin teeth, with minute convex terminal umbels; (4) thin spicules which run out to a point at one extremity, and are provided on the other somewhat expanded end with five to eight bristle-like narrow prickles which project in a brush-like manner. These various spicules, which occurred in special abundance in the neigbourhood of the surface, were regarded by Oscar Schmidt as sufficiently characteristic of a new species distinct from the *Farrea occa* of Bowerbank, and this he designated *Farrea facunda*.

In the same year (1870) Saville Kent described,[4] along with several other Hexac-

[1] *Proc. Zool. Soc. Lond.*, p. 339.
[2] *Ann. and Mag. Nat. Hist.*, 1868.
[3] Spongien des Atlantischen Gebietes, p. 16.
[4] *Monthly Micr. Journ.*, November 1870.

tinellida collected on the coasts of Spain and Portugal, a full-grown siliceous skeleton which he identified as *Farrea occa,* Bowerbank.

This form consists of a continuous branched tube exhibiting anastomoses here and there, and measuring from 5 to 8 mm. in diameter. The tube opens by a slightly funnel-shaped, expanded and projecting cup about 1 cm. in width. To conclude from the figures given [1] all the tubes consist only of a simple framework with quadrate meshes. Although in this the specimen described by Saville Kent quite agrees with the network of siliceous beams, regarded by Bowerbank as the dermal skeleton of his *Farrea occa,* yet it differs from the latter in the circumstance that the beams of the framework are not smooth externally, but are beset with pointed tubercles. In this character it rather resembles the siliceous network regarded by Bowerbank as part of the inner body skeleton of his *Farrea occa.*

On the same *Lophohelia* stock upon which the specimen which was determined as *Farrea occa,* Bowerbank, had been found, Saville Kent also observed some "small fistulose ramifications bridging over the minor interspaces between the branches of the coral." He regarded this sponge, in spite of the great similarity with the adjoining *Farrea,* as a species belonging to another, and even a new genus, which he named *Aulodictyon.* From the genus *Farrea* this is said to differ in the following points :—"In *Farrea* the basal skeleton is composed of a single reticulated lamina; in *Aulodictyon* the basal skeleton consists of a complex reticulate tube between, and continuous with the primary meshes, of which an abundant network of coalescing simple hexradiate stellate spicula occurs." Moreover "the minuter spicula of the sarcode" are also said to be "of an entirely different type." And since Oscar Schmidt had, in the case of his *Farrea facunda,* described no single-layered dictyonal framework in the basal part, but a complicated network of several layers, and isolated spicules, similar to those found by Kent in his *Aulodictyon,* the latter was of opinion that Schmidt's *Farrea facunda* ought to be referred as *Aulodictyon facundum* to his new genus.

As I shall show further on, however, all tubular species of *Farrea* have in their basal portion a dense dictyonal framework of several layers, and also the "long attenuate spicules inflated at the extremity and reflecto-peltate, with a dentate margin or with a simple series of recurved hooks," which Kent looks upon as characteristic peculiarities of his genus *Aulodictyon.* Consequently the genus *Aulodictyon* must be entirely abandoned.

In the survey of all the above described Hexactinellida which Carter gave in 1873,[2] this accurate observer first sharply distinguishes the two siliceous networks found on the already often mentioned original specimen of *Euplectella cucumer*, Owen. These had been described by Bowerbank as dermal and body skeleton of one and the same sponge, while

[1] *Loc. cit.*, pl. lxiv. figs. 12, 13, 14.
[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 360.

Carter distinguished them as body skeletons of *two different species* which he named *Farrea occa*, Bowerbank, and *Farrea densa*.

Carter confined the name *Farrea occa*, which had been applied to both parts (taken together), to the siliceous network (regarded by Bowerbank as a dermal skeleton), which consists throughout of one layer, surrounds exactly square meshes, and bears at the intersections rough conical pegs on both sides. In justification of this, Carter notes that only this skeletal portion in reality resembles a harrow (*occa*), and that it had therefore been specially considered by Bowerbank in applying the name.

In his examination of this species (*Farrea occa*, Bowerbank), besides using some of the fragments collected during the "Porcupine" Expedition, and the specimens studied by Saville Kent, Carter also employed the fragments which had been obtained from the basal tuft of the beautiful *Euplectella cucumer* studied by Owen. He was, however, only able to procure completely macerated and greatly eroded specimens, and accordingly could not study the spicules that occur freely on the soft parts. Yet he believed that some spicules which were casually included here and there in the continuous framework of beams might with probability be interpreted as belonging to *Farrea occa*. With regard to the formation of central canals in the beams of the siliceous framework Carter was convinced from the direct examination of these numerous remnants of *Farrea occa*, that the entire network of beams, with its rectangular meshes, had not originally possessed a continuous canal system, but, as this arose by the amalgamation of isolated hexradiate spicules, it at first consisted merely of the separate hexradiate canals, which terminated blindly at the six extremities, and belonged, of course, to the individual hexradiate spicules. These separate axial canals corresponding to the individual hexradiate spicules usually became very manifest after the death of the animal. On account of internal absorption or solution they are specially wide and striking, and this points to a previous more prolonged maceration of the dead sponge.

A sponge described by Carter under the designation of *Farrea infundibuliformis*, from the Caribbean Sea, presents a small funnel-like body, with a much widened thin margin, having an opening of about $2\frac{1}{2}$ cm. in diameter, and with a solid round stalk of about 1 cm. in length and $\frac{1}{2}$ cm. in thickness. The sponge is attached to its stratum by means of the somewhat expanded inferior extremity of the stalk. The skeletal framework of the solid stalk consists of a dense lattice-work, with more or less distinctly defined rectangular meshes, and is continuous with the skeleton of the funnel-like plate, so that in the middle of the plate a rectangular lattice-work remains, while more irregular networks of fibres extend over the two surfaces. The beams of the rectangular lattice-work are beset with small spines, those of the irregular network of fibres exhibit still finer spines and bear numerous simple, hexradiate, lateral spicules. In such soft parts between the foramina of the siliceous network as were visible in the dried condition, Carter found numerous floricomes with minute laterally spinose terminal knobs.

During 1875 and 1876, in his Monograph of the Silico-fibrous Sponges, parts iii.–vi.,[1] Bowerbank ascribed no fewer than fourteen new species to his genus *Farrea*. These he names *Farrea gassioti*, *Farrea pocillum*, *Farrea fistulata*, *Farrea lævis*, *Farrea parasitica*, *Farrea valida*, *Farrea spinosissima*, *Farrea spinifera*, *Farrea spinulenta*, *Farrea aculeata*, *Farrea robusta*, *Farrea inermis*, *Farrea perarmata*, and *Farrea irregularis*. Since, however, the description of these new species was usually based only on a small fragment without characteristic form, and withal more or less macerated and injured, it is impossible, in most cases, to determine (notwithstanding the perfect figures given under a magnifying power of 36 or 80 diameters) to which species the fragment in question properly belongs. It is much to be regretted that, in almost all these Bowerbankian species of *Farrea*, the free spicules of the dermal system were not preserved or are not sufficiently clearly figured, and accordingly the words used by Bowerbank at the close of the introduction to the monograph referred to must be employed; he says:—"When the expansible dermal system is present, wholly or in part, in specimens under examination, we are enabled to establish specific characters of external form and structural peculiarities of the most satisfactory description, but when that important portion of the organic structure of the sponge is absent the characters derived from the form and surface of the rigid skeleton are *necessarily provisional*, and can maintain their places in its description only until a specimen in a natural and perfect state can be procured." Since Bowerbank, moreover, lays the very greatest weight on the width of the axial canals and regards these—as his generic diagnoses "fibres canaliculated, canals continuous" indicate—as at least essentially in a condition of perfect continuity, whereas, as Carter has already observed, in the skeletal framework of the Hexactinellida, the axial canals of the individual hexradiate spicules are at first unconnected, while the width depends chiefly on the condition of the skeleton as regards maceration or solution, it is conceivable that the specific characters and differential features given by Bowerbank have often little value.

The two types indicated by Bowerbank (*loc. cit.*, p. 272) as *Farrea gassioti*, and *Farrea pocillum* agree so thoroughly in form, size, and structure that it is really only the different breadths of the central canal of the network of beams that form the difference. But this distinction is seen to be insignificant when it is observed that, even according to Bowerbank's own statement, some greatly macerated specimens of *Farrea gassioti* have the central canals remarkably wide and clear. Further, in the case of the two specimens of *Farrea pocillum*, which have the soft parts dried and richly provided with the included isolated spicules, and which were accordingly, without doubt, secured as fresh specimens, the canals are especially delicate, and in some places even almost imperceptible. Moreover, the great similarity in form, size,

[1] *Proc. Zool. Soc. Lond.*, 1875, 1876.

and structure, which these two Bowerbankian species bear to the *Farrea infundibuliformis*, Carter, which was described two years previously by Carter,[1] but was entirely unknown to Bowerbank, is certainly striking. Bowerbank, indeed, says nothing of the elegant floricomes, which Carter's specimen possessed in rich abundance, but it is quite possible that these fine forms may have escaped Bowerbank in the course of his examination, and that accordingly all three species may perhaps be united into one.

The fragment which Bowerbank has designated as *Farrea fistulata* consists of a bent tube of 23 mm. in length and 6 mm. in transverse diameter. It is not only open at both extremities, but further exhibits a lateral orifice to which a short tube of equal width is attached. The skeleton with its two or three square lattice-layers consists of smooth, cylindrical beams, with wide central canals. From the intersections of the outer as well as of the inner surface tolerably long tuberculated teeth project. Bowerbank also describes a thin dermal membrane with numerous spicules; but since the latter are called "acerate" and "contort bihamate," and since, moreover, a specimen of *Hymedesmia johnsoni*, Bowerbank, which is distinguished by "acerate" and "trenchant contort bihamate" spicules, was found to have settled in the interior of the tube, there can be no doubt that those free spicules of the outer skin-like casing do not belong to the Hexactinellid any more than the spicules of those Desmacidonids which are firmly fixed in the interior. The whole fragment may have lain dead for a long time on the bottom of the sea before it was brought up, and the width of the central canal of the beams is on that supposition readily explained.

Farrea lævis is the name given by Bowerbank to a new species, of which he possessed only a small fragment, consisting of a tube-like siliceous network from 4 to 5 mm. in breadth, and scarcely 1 cm. in length. Since the entire system of beams which encloses approximately square meshes only forms a single layer, Bowerbank looks upon this as a "dermal network." The beams of the network are smooth throughout, and so too are the long conical teeth which project outwards and inwards at right angles to the intersections. The central canals, of which two, or sometimes even three, lie close to one another, are very wide, and become confluent at the angles.

Since the small fragment found in dredged sand was provided only in one small place with a thin skin consisting of a dried soft mass *without* any spicules, it may be inferred that the skin did not belong to the sponge, and here too, the breadth of the central canals was caused by longer solution in sea-water. Bowerbank finally notes the great resemblance between his *Farrea lævis* and the branched, partially anastomosing, tubular network, figured by Saville Kent[2] and designated *Farrea occa*. He also calls attention to the fact, that that branched tube-like form agrees with a certain "*Farrea tubulata*." I have carefully endeavoured, but to no purpose, to discover in

[1] *Ann. and Mag. Nat. Hist.*, vol. xii. p. 448, 1873.
[2] *Monthly Micr. Journ.*, pl. lxiv. fig. 12, 1870.

the literature of the group something about this *Farrea tubulata*, which, so far as I am aware, is referred to only in this place.

As to the irregular network of beams with central canals of various widths, which adhered to the inner side of a *Farrea gassioti*, Bowerbank, and which is spoken of by Bowerbank as *Farrea parasitica*, one can scarcely say more than that it belonged to a Hexactinellid, for the fact of its connection with the genus *Farrea* is not even plausible from Bowerbank's own description and figure.

The *Farrea valida* of Bowerbank was established upon a small fragment of a reticulated skeleton. The fragment, which is regarded by Bowerbank as representing the dermal skeleton, is distinguished by the possession of uniform square meshes, by thick, smooth, tubular beams in the network, and by short, tuberculated, conical teeth and prickles. This dermal skeleton is associated with an inner body skeleton formed of distinctly thinner, smooth beams, but of this skeleton little is preserved. The numerous hexradiate crowded spicules, which are placed upon, and have one ray at right angles to the beams of the framework, are noteworthy.

Bowerbank designates by the name of *Farrea spinosissima* a fragment of a skeleton, consisting of several reticulated layers, and provided with more or less square meshes. From the tubular beams, which are of various thickness, though generally slender, numerous long pointed prickles project at right angles, and are either smooth or slightly beset with spines.

Farrea spinifera was erected by Bowerbank on the basis of a skeletal fragment, whose beams, which are of various thickness and provided with a central canal, surround more or less regular meshes, and are distinguished by long, transversely disposed, or slightly conical prickles.

A small skeletal fragment, which Bowerbank has named *Farrea spinulenta*, differs from most of the others hitherto referred to in the very convenient circumstance, that in the present case a portion of the soft tissues, along with the free spicules that occurred in them, was preserved in the dried specimen. It is true that here also it is not quite certain whether the dried mass in question really belonged to the same sponge as the siliceous skeleton, but it is in the highest degree probable. The framework consists of a simple network with square meshes and long rough teeth, which project on both sides at right angles to the knots of the network.

As was to be expected, Bowerbank failed to find any central canals in the beams of the siliceous network of this fragment, which was certainly taken from the sea bottom in a living condition. The skeleton was not yet macerated and dissolved internally like the majority of the other specimens of various species of his genus *Farrea*, which have been referred to above. These apparently solid beams of the network are, however, not quite smooth, but are beset with small pointed tubercles or with parallel longitudinal rows of fine prickles, which stand at equal distances from, and alternate with one

another. Among the free spicules which are present in the soft parts, and are especially abundant in the skin, Bowerbank notes simple hexradiate spicules, with smooth or finely fringed rays, and also floricomes, with small terminal plates on each of the four S-shaped terminal rays of every principal ray. Bowerbank notices the great resemblance between this species and *Farrea occa*, but he at the same time calls attention to some small differences, such as the slightly roughened surface of the beams of the network, the slender form of the teeth, and the peculiar floricomes.

Of *Farrea aculeata*, Bowerbank, the author possessed only a fragment, the form of which pointed to a cup-like form for the animal. The usually two-, more seldom three-layered lattice-like framework consists of strong, canaliculated, siliceous beams, which surround tolerably regular square meshes, and are irregularly beset with conical prickles and thorns of various sizes. Here and there hexradiate spicules which have grown upon the above also occur. This species has a striking resemblance to *Farrea spinifera*, as Bowerbank himself recognised.

The skeletal framework of *Farrea robusta*, Bowerbank, has a close resemblance to that of *Farrea aculeata*. It differs from it strictly only in the greater size of the beams and in the corresponding narrowness of the square meshes, as also in the greater thickness of the fully developed rough hexradiate spicules—differences which everywhere occur between older and younger parts of the same sponge. The soft parts and Monactinellid spicules found by Bowerbank in the framework are quite independent, and belong to a Desmacidonid which had settled in the skeleton after the death of the Hexactinellid.

Another fragment of a siliceous framework with several lattice-like layers, and provided on both surfaces of the somewhat bent plate with meshes which are uniformly square but more irregular in the interior, Bowerbank has named *Farrea inermis*, because the beams are entirely or almost entirely smooth. From the knots of the network slender smooth teeth project at right angles. Similar prickles also project here and there into the inner meshes.

Bowerbank has designated as *Farrea perarmata* a flat, slightly bent, skeletal fragment in which the framework of beams, which forms square meshes, is everywhere richly beset with spines and prickles of various sizes, and exhibits no recognisable central canals. Long rough conical teeth project outwards and inwards. Numerous thorny hexradiate spicules also occur with one ray in each directed at right angles to the beams of the network.

Another bent skeletal fragment, consisting of a tolerably irregular framework of beams which here and there exhibit square meshes, Bowerbank names *Farrea irregularis*. The individual beams have a very varied thickness, and for the most part perfectly smooth, isolated, small hexradiate spicules also occur.

If we review these fourteen species established by Bowerbank during the years

1875 and 1876, we can obtain only in four cases any adequate conception of their form; namely, on the one hand, in the case of *Farrea gassioti* and the very closely related *Farrea pocillum*, both of which have the same cup-like form; and on the other hand, in the case of *Farrea fistulata* and *Farrea lævis* both of which are tubuliform and are also closely related to one another. Which of the other ten species belong to the one or the other of these two groups of forms, or perhaps to neither, it is scarcely possible to say on account of the small size and imperfect condition of the fragments examined. According to Bowerbank's own representation his *Farrea spinulenta* seems to agree for the most part with the old *Farrea occa*, Bowerbank, so far as regards the lattice-like framework. If this agreement were indeed more intimate it would be of great importance for the establishment of the generic character of *Farrea*, because some free siliceous spicules were found and described by Bowerbank in the dried soft parts, and these are absent in the other cases. We must regret that Bowerbank has communicated no definite information in regard to the free spicules which he mentions as having been found in "various forms" in an original fragment of his *Farrea occa* (and indeed in the so-called dermal skeleton); he only says (page 561) that in *Farrea spinulenta* one may find that "the large simple rectangulate sexradiate interstitial spicula with spinous radii, a few of which are entangled in the inner surface of the dermal rete, also form efficient specific characters, none such having hitherto been found in *Farrea occa*."

In his description of the sponges of the Gulf of Mexico—1880—Oscar Schmidt maintains his previous diagnosis of the species *Farrea facunda*. To the spicules then described as characteristic he adds a hexradiate form in which every individual ray divides at the extremity into from two to four (usually three) fine bristle-like teeth, and he conjectures that in the previously examined specimens certain spicules represented on his pl. v. fig. 9, which bear on each of their thickened extremities four transversely arranged and somewhat recurved hooks, might be present as well as in the specimens subsequently studied. He further reports that in the majority of his numerous specimens those peculiar broom forms (Besengabeln) figured on pl. i. figs 18, 19,[1] and in some the umbelled spicules represented in fig. 2 of the same plate, were not to be found. He is, however, by no means inclined to erect a specific difference on that account, and that the less since the familiar fir-tree-like spicules occurred here and there instead of the absent "brooms." Only one form—in which the absent umbel and hook spicules are represented by the so-called knob-broom form, that is to say, by forks with several teeth which do not run out to points but terminate in terminal knobs, and which were in the meantime described by Carter as *Eurete farreopsis*—should be excluded from his *Farrea facunda*, and at any rate become the representative of a special species. On the other hand, the genera *Eurete* and *Aulodictyon*, which were placed near *Farrea* by Semper

[1] Spongien des atlantischen Gebietes, 1870.

and Kent, he regards as untenable, and would without further delay unite them to *Farrea*. According to Schmidt's view all the forms ascribed to these two genera, with the single exception of Carter's *Eurete farreopsis*, belong to the circle of forms round his *Farrea facunda*.

In a Report on a Collection of Marine Sponges from Japan, made by Dr. T. Anderson, Carter gives a detailed and accurate description of the skeleton of a Japanese *Farrea*, which he designates *Farrea occa*, Bowerbank.[1] The conical and branched tube exhibits in its upper portion "an extremely thin and delicate reticulated wall, rendered denser lower down (towards the base) by additional matter of a similar kind. Extremities of the branches open and dilated. The points of intersection of the quadrangular reticulum are marked on each side by a long, curved, spiniferous process or spur, which is directed upwards, thus supporting the sarcode or soft parts and its spicular contents, both externally and internally, that is, on each side of the skeletal wall." The loose dermal spicules exhibit five forms, viz., (1) hexradiate with outer ray aborted; (2) acerate, straight, unsymmetrically fusiform, sharply pointed at each end, spinose at short intervals throughout ("barbulæ"); (3) nail-shaped forms, with a long straight shaft, slightly swollen and pointed at the free end, and expanded horizontally at the other into a circular head, more or less spinose at the edge, very abundant and varied; (4) hexradiate rosettes with four straight arms without central swelling, ending in four divergent rays disposed round a central one, rays smooth and simply pointed, or else more or less capitate and beset with small spines; (5) smaller hexradiate forms, in which all the four rays are equally developed, straight, pointed and spinose.

Since Carter has designated this *Farrea* from Japan (off Misaki) by the title *Farrea occa*, and described it with sufficient clearness to admit of its being recognised, Bowerbank's name may be retained for this definite form. Pls. LXXI., LXXII., LXXIII., and LXXVI. were printed before I received Carter's paper, so that I was unable to change the specific designation *Farrea haeckelii* into *Farrea occa* (Bowerbank) Carter.

Generic Character.—A simple tubular stalk, attached by its compact expanded base, bears a dichotomously branched anastomosing tube-work, the walls of which are supported by a dictyonal framework with rectangular meshes. In older specimens the dictyonal framework is below of more than one layer, but it becomes gradually thinner towards the upper end, and finally forms a single-layered meshwork. From each of the intersections of this network a stout rough spine projects at right angles both inwards and outwards. Besides the pentact hypodermalia and hypogastralia other dermalia occur as clavulæ with a nail-like, clavate, or verticillate shape. Besides uncinates, the parenchyma contains oxyhexasters, and in some species discohexasters.

Many species of *Farrea* have been already erected and described, but mostly with

[1] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. xv. p. 387, 1885.

reference to macerated specimens. Only one of these can I regard as sufficiently diagnosed to permit of certain recognition, namely, the form lately described by Carter, and designated by him as *Farrea occa*, Bowerbank.

1. *Farrea occa* (Bowerbank) Carter (Pls. LXXI., LXXII., LXXIII.; Pl. LXXVI. figs. 1–3).

Both the material of the Challenger Expedition and the collection of the Hexactinellida brought by Dr. Döderlein from the Sagami Bay, Japan, include numerous specimens of this species of *Farrea*. These are partly spirit specimens with the tissue preserved, and partly dried forms. They exhibit considerable differences both in size and form.

It is unfortunate that not one of all the specimens is quite intact. The outermost ends of the tubes are generally broken off for a greater or less distance. I hope, however, that the representation given in Pl. LXXII. fig. 1, of a macerated skeleton in lateral aspect, and those in Pl. LXXI. figs. 1 and 2, from photographs of spirit specimens in lateral and superior aspect, will give a correct conception of the general habit of this sponge. It is frequently richly branched, forming composite masses sometimes 12 cm. in height.

The simple hollow stalk is attached by a flat expansion to a more or less compact substratum, sometimes consisting merely of a crumbly mass of clay. This expanded portion consists of an irregular tuberculate plate, which is closely appressed to the substratum. In its centre it has a thickness of 0·3 mm. or more, but becomes gradually thinner towards the irregularly frilled edge, forming a delicate smooth margin. On the free upper surface of this compact basal plate there are usually some radially disposed furrows, from 1 to 2 mm. in breadth, which sometimes divide externally into two or three narrower branches. From the lumen of the round tubular stalk which rises from the middle of the plate, a round excurrent aperture leads either through the plate itself straight downwards, or just above the plate through the wall of the tube (Pl. LXXII. fig. 2). The stalk, which usually stands erect at right angles, has a diameter of 5 to 10 mm. and an equally short length. It passes immediately by division and gradual expansion into the crowded anastomosing tube-work of the stock. The ultimate ends of the tubes form thin-walled smooth margined cups projecting freely on the somewhat uniformly arched convex surface of the whole complex. The dichotomous division of the single tubular ends takes place in the following fashion. The cup-shaped expansion extends transversely, usually at right angles to the last plane of bifurcation, the two long parallel margins thus formed approach one another in the middle and fuse, so that the cup becomes divided into two independent and diverging tubes (Pl. LXXII. fig. 3). After a more or less prolonged growth these again experience a dichotomous division of the same sort. The length of the tubular portion seems to vary greatly in different stocks and also in the

different regions of one stock. In Pl. LXXII. fig. 4 I have represented a fragment of a specially elongated tubular system. This was trawled to the west of Manila (Station 207, lat. 12° 21′ N., long. 122° 15′ E.) from a depth of 700 fathoms and a blue mud ground, while in contrast to this the specimen trawled in the Bay of Sagami by Dr. Döderlein, from about 150 fathoms and a clay bottom (Pl. LXXI. fig. 2), exhibited quite short tubular branches of at most 1 cm. in length. In the largest specimen of this lot, which is figured in Pl. LXXII. fig. 1, the tubes have a length of only 1·5 to 2 cm.

In the spirit specimens, in which the whole soft tissue remains perfectly intact with the dermal and gastral membrane, both the external and the inner surface are uniformly marked by fine dark points arranged in transverse and longitudinal rows crossing at right angles (Pl. LXXI. fig. 2). Where the soft tissue has been removed by maceration or by mechanical means, the beautiful quadratic network of the dictyonal framework is more or less distinctly seen (Pl. LXXII. figs. 1, 3).

The diameter of the tubes increases continuously from the simple basal portion to the freely projecting, widely open, terminal cups. On quite young specimens only a few centimetres in height, the stalk measures hardly 3 mm. in breadth, just above the plate of attachment, while in older specimens external thickening results in a transverse diameter of 5 to 10 mm. While the cup-shaped ends of the tubes in young specimens have usually a width of only 5 mm. or so, the terminal openings of the large stocks are frequently 15 to 20 mm. in diameter.

Since the dichotomous ramification begins at a very early stage at variably distant intervals and not in the same plane, but in planes often disposed at right angles to one another, no long straight main trunk results, but an irregular much twisted system of tubes, expanding on all sides. The anastomosis seems to occur partly as the result of direct union between newly formed tubes which meet one another in their growth, and partly as the result of the apposition of adjacent tubes which are at first externally united, and afterwards come into direct communication by the absorption of the intervening partition. Now and then, but on the whole rarely, I have observed one or other of the tubes, bent downwards or to the side, and closed by a transverse porous plate, while all the others remained open. I can only regard such a closure as an abnormality, which has probably resulted as a protection against the injurious influence of mud or the like.

In regard to the microscopic structure of the *dictyonal* framework, I have in the first place to notice, in opposition to the previous statements of other investigators, that the greater part of the whole tubular system, and especially the superior youngest portion, is supported by a single-layered network, but that in the lower, and therefore older portions, and also at the base of all the stocks which are not very young, the framework exhibits two layers or more (Pl. LXXIII. fig. 2; Pl. LXXVI. fig. 3). The network encloses approximately cubical meshes. This many-layered framework has undoubtedly arisen in this way, that to each distal ray of the single-layered lattice-work the proximal

ray of a hexact of the new outer layer is apposed, and both become enveloped in a common concentrically laminated siliceous sheath. It is obvious that in this way the older and lower portions of the tubes may gradually increase in thickness.

The thick, firm, spongy mass, which forms the pedicel on the older stocks and the flatly expanded basal plate, has had another origin. Besides the apposition of a new layer of the cubical lattice-work, we have here to deal with the interposition of numerous smaller hexacts in the already formed meshes. And while the external apposition of new layers leads in general to the regular formation of rectangular or cubical meshes, the interposition of small hexacts does not usually occur in the radial tangential direction, but at very various angles to the main strands, so that an irregular narrow meshed network results (Pl. LXXVI. fig. 2). Where the basal plate is in direct contact with the substratum, as in all other Hexactinellids fixed on a solid basis, a narrow meshed bounding plate is formed, which arises mainly by the abundant development of synapticula between the bands of spicules.

While the strands of the single-layered dictyonal network which lie parallel to the surface of the tube are cylindrical and smooth, the intersections of the net exhibit conical prominences projecting at right angles both outwards and inwards, and always beset with small tubercles or rough elevations. In the many-layered dictyonal framework, the radial beams extending between the layers, which lie parallel to one another and to the tube wall, exactly resemble the tangential beams in their cylindrical shape and in their smooth surface, while here also the prominences projecting from the outer and inner surface of the whole lattice-work are always tubercled and rough. The length of these freely projecting conical prominences varies as much as their form, and that between tolerably wide limits. They are generally straight or only slightly curved; are longer in the younger portions, especially in the single-layered framework, and shorter on the surface of the many-layered framework of the older regions. On the surface of the stalk and on its basal expansion they are either altogether absent, or represented only by small knob-like elevations.

At the points of intersection of the dictyonal framework there is a slight thickening gradually increasing with age, but this is not in any way marked off from the strand, nor different from the latter in the character of its surface.

The composition of the whole framework from separate hexacts may be most readily recognised on those specimens which have remained dead in the sea for some time and are thus macerated. The axial canals of the individual hexacts have through the dissolution of the loose inmost layers become more or less markedly widened, and are thus in their disposition and extent readily observed (Pl. LXXVI. fig. 5). In fresh specimens, however, they can usually be detected as very fine canals (Pl. LXXI. fig. 3, &c.)

The length of these axial canals is often surprising. While they usually extend only

to the proximity of the axial cross of the next spicule, where they are rounded off and terminate, they are sometimes continued right along to the middle of the second spicule; thus three axial canals may not unfrequently be seen running alongside in one strand.

In his last description of *Farrea occa*[1] Carter states that the conical prominences which project freely on either side of the narrow meshed lattice-work are bent outwards. I cannot, however, admit the accuracy of this as a general statement. As a rule the prominences are straight and directed at right angles to the surface. As Carter correctly notes, they gradually decrease in length towards the base of the stock.

As to the loose parenchymalia lying between the beams of the dictyonal framework, I shall first discuss the *uncinata*. These have been already well described and figured by Carter (*loc. cit.*). His description is as follows:—"Acerate, straight, unsymmetrically fusiform, that is, the outer or projecting part being thicker than the inner two-thirds of the spicule, which is thus rendered long and whip-like; sharp-pointed at each end, spined at short intervals throughout, the spines long, smooth and slender, respectively supported on bracket-like processes, which, being spirally arranged around the shaft, give it an irregular zig-zag appearance, all sloping in the same direction, that is backwards, or towards the sponge, at a very slight angle upon the shaft, whose outer or thickened end is extremely sharp." He calls them barbulæ,[2] a diminutive of the English barb, and says that they are "common to almost all the Hexactinellida." This assertion I cannot, however, admit. Among the numerous Lyssacina which I have examined, structures like these uncinates only occur in the genera *Pheronema, Poliopogon,* and *Semperella.* Among the Dictyonina I have not found them in the genera *Myliusia*, Gray; *Dactylocalyx,* Gray, *Scleroplegma,* O. Schmidt, *Margaritella,* O. Schmidt, *Euryplegma,* F. E. S., *Joanella,* O. Schmidt, and *Aulocystis,* F. E. S., and these may therefore be designated as Inermia, in opposition to the Dictyonalia with uncinates—the Uncinataria.

As Carter notes, the uncinates exhibit in *Farrea occa* an extraordinary variability in length, though this depends to some extent on the age of the individual uncinates and of the regions of the sponge in which they occur. Further, in the form, number, and arrangement of their inturned spines, there are in one and the same sponge very marked differences. Rarely, and only in the younger portions of the tubes, I find the spines distant and very divergent from the stem as represented in Pl. LXXI. fig. 4, and Pl. LXXIII. fig. 3. Sometimes a spiral arrangement of the spines can be detected; in other cases this is impossible, and the distribution appears to be quite irregular. The expansion of the distal third portion of the uncinates as contrasted with the interior is very marked, especially on the large and strongly developed forms, where, too, the inner end is not unfrequently distinguished from the outer by the development of weak spines.

[1] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. xv. p. 388.

[2] Since I had used the Latin term *uncinatum* (a rod beset with barbs) before I received Carter's memoir, and since Latin or Greek terms seem to me to have the preference as being cosmopolitan and not national, I have adhered to my original designation.

All the uncinates in *Farrea occa* are disposed at right angles to the surface, and thus traverse the wall of the tube in a radial direction. The sharp external point does not, however, penetrate the dermal membrane, but at most reaches it. The inner weaker, and always pointed ends remain at some distance from the gastral membrane, varying according to the relation between the length of the uncinates and the diameter of the tube-wall.

Besides the uncinates, parenchymalia are represented by simple oxyhexasters in more or less abundant occurrence. In these the long smooth principal rays divide into two to four widely diverging, straight or gently curved terminals, half as long as the principals (Pl. LXXI. fig. 7). These oxyhexasters occur most abundantly in the subdermal and subgastral trabecular space, but more sparsely in the middle layers of the tube-wall, even between the chambers, without, however, being altogether absent (Pl. LXXI. fig. 3; Pl. LXXIII. fig. 2). They are embedded in the trabecular network itself, and I am inclined to think that the formation of the trabeculæ and their interconnection is of the greatest importance in relation to the form of these spicules. In Carter's specimen of *Farrea occa* the terminal rays of the rosettes were as a rule smooth and pointed, though occasionally microspined and more or less "capitate." In the specimens which I examined, on the other hand, there were never any traces of terminal knobs or discs on the terminal rays of the rosettes, that is to say, of transitional forms between oxyhexasters and discohexasters. I have, however, found specimens of *Farrea* in which the rosettes were exclusively discohexasters, and these of an unusual type, but these were representatives of a second species, namely, *Farrea sollasii*. Other specimens in which, besides the oxyhexasters, discohexasters also occurred, belonged to a third species, *Farrea vosmaeri*. But if the different forms of rosettes as above noted really occur in one and the same sponge, with distinct transitional types, then the forms which I have designated as two distinct species, *Farrea sollasii* and *Farrea vosmaeri* may perhaps be regarded as varieties of *Farrea occa*. I have not, however, as yet discovered such transitional forms, and shall therefore meanwhile continue to regard these divergent specimens as distinct species, until their relation to *Farrea occa* be indisputably established.

Besides the uncinates and the above mentioned rosettes, the parenchyma of *Farrea occa* contains simple hexacts, of the same size as the rosettes, with smooth or rough, straight, pointed rays, which usually exhibit a knob-like thickening on their point of intersection. While these simple oxyhexacts have only a rare and isolated occurrence in the upper younger portions of the *Farrea* stocks, they are abundant in the lower portion, and in older stocks even numerous in the pedicel, and in the basal plate, within the meshes of the dictyonal framework, where they are abundantly fused to the dictyonal beams, so that by the gradual thickening of the rays, and their union with adjacent strands, they contribute to the thickening and compacting of the connected skeleton.

The dermal membrane of *Farrea occa* is supported by the four rectangularly intersecting tangential rays of simple pentacts, whose fifth rays penetrate into the parenchyma at right angles to the surface of the tube, while here and there a tubercle or knob-like distal elevation remains as the persisting trace of a sixth (distal) ray. While the proximal ray is always perfectly straight and slightly narrowed into a conical form towards the pointed end, the four tangential rays are usually bent gently inwards, and end in a slight usually blunted thickening, or in a somewhat knob-shaped swelling (Pl. LXXI. fig. 6). The proximal ray usually exceeds the tangential in length, is always cylindrical, and generally smooth with the exception of a slight roughness at the point. The tangential rays, on the other hand, are somewhat flattened on their outer side, and beset with smaller or larger tubercles which are sometimes pointed, sometimes rounded and boss-like. These tubercles or spines are usually strongly developed only on the gently convex and somewhat flattened side; on the lateral edges they are more weakly developed, and are altogether absent on the inner side of the tangentials. In some cases they have an isolated occurrence on the internal side. Towards the end of the rays the spines increase in height, and occur more densely and all round.

The disposition of these pentacts in the dermal membrane is frequently after this fashion, that the quadratic framework, which is formed from their apposed tangential rays, corresponds exactly to the subjacent dictyonal framework, each proximal ray being apposed to a distal prominence of the latter, and the tangential rays lying parallel to the beams of the dictyonal lattice-work. The meshes of the dermal lattice-work thus of course correspond in size to those of the dictyonal framework.

In other cases, as for instance in that on which the figures on Pl. LXXII. fig. 5 and Pl. LXXIII. fig. 1 were based, each distal prominence of the dictyonal framework corresponds indeed to the proximal ray of a dermal pentact, but besides this there is above the middle of each mesh of the dictyonal lattice-work a dermal pentact; and the tangential rays of all the dermal pentacts do not lie parallel to the beams of the dictyonal lattice, but diagonally to the quadratic or rectangular meshes. Often enough, however, no definite relation between the dermal pentacts and the dictyonal lattice can be determined except this, that above most of the distal rays of the latter there occurs a pentact of the dermal skeleton. The extent to which the corresponding opposite tangential rays of two adjacent dermal pentacts may overlap one another, varies in the different regions of the sponge. Each tangential ray frequently reaches almost to the nodes of intersection of the neighbouring pentact (Pl. LXXII. fig. 5).

Besides the pentacts above described, the dermal skeleton of *Farrea occa* contains clavulæ, which are so far in connection with the former since they always lie close beside the proximal ray. While they form an externally divergent tuft, the inferior pointed ends of the long stalk are usually in contact with the proximal ray of the related pentact, and the heads with their convex terminal discs lie about the level of the dermal membrane or

project more or less beyond it, and fill up to a greater or less extent the four angles of the cruciate tangential rays of the pentact. Contrary to Carter's report, according to which six clavulæ usually accompany each pentact, I generally found eight round each in the best preserved specimens, and disposed so that two lay in each of the angles of the tangential rays. This number does not seem, however, to be in any way constant. Not unfrequently I have found ten or more clavulæ in one bundle, and very frequently fewer than eight, and sometimes very few. It is difficult to determine whether they may be sometimes wholly absent; where this appears to be the case, it is quite conceivable that they may have fallen out or have been torn away. Nor does the fact that they frequently project more or less beyond the surface of the skin necessarily imply that they have this position in the living sponge. On the contrary, in the best preserved specimens the normal position seems to be that in which the hemispherical terminal discs occur within the dermal membrane. Deformation of the body-wall or pressure of apposed foreign bodies has forced them outwards, as may be inferred indeed from their shape.

The form of the dermal clavulæ in *Farrea occa* varies considerably, as Carter has already noted, and that between somewhat wide limits, from the long-toothed umbels to the smooth club (Pl. LXXII. fig. 8), nevertheless one definite form is so predominantly frequent, that it may be regarded as the normal type, of which all the others are only exceptional modifications (Pl. LXXI. figs. 5, 9). This typical dermal clavula exhibits a club-shaped or poppy-head-like terminal swelling, which is externally and laterally roofed over by a hemispherically arched umbel, frequently raised in the centre into a projecting boss. The overhanging margin of the umbel is toothed. The teeth, which number eighteen to twenty-two are either simple marginal teeth resulting between notches of the margin, or are more or less sharply defined off from the edge and laterally compressed even at the base. The cylindrical stalk is gradually narrowed towards the lower, simply rounded extremity, and is usually straight or gently bent, and, like the poppy-head-like extremity, is beset with small irregularly disposed tubercles, which increase somewhat in size and number towards the narrowed lower end (Pl. LXXI. fig. 5).

Various deviations from the above described typical form often occur both in different regions of the same sponge and in specimens obtained from different localities. The variation is especially associated with the terminal portion which we have shortly designated the "head." In thickness and length, for instance, it varies greatly. In many cases the stalk shows towards its upper end at most a gentle thickening, which bears terminally a thin toothed umbel like that of a toad-stool, while in others there is a broad club-shaped terminal portion from which the umbel region is but slightly, or even not at all marked off, so that a perfectly smooth club-like swelling may result. While the terminal portion of the umbel is sometimes quite flat and without any central elevation

(Pl. LXXI. figs. 5–9), it is not unfrequently markedly arched, and frequently bears a more or less sharply defined central papilla. The toothed outer margin extends for a varying width beyond the centre of the head, or may on the other hand be reduced to a simple smooth fringe (Pl. LXXII. fig. 8), or even wholly disappear. The number and size of the marginal teeth are very variable. The normal number, twenty, is rarely greatly exceeded, and frequently not attained. I may, however, call attention to the fact that among the dermal clavulæ I have never found the anchor-like forms with eight to four long curved rays, which occur so frequently on the gastral side. This marked difference may sometimes be utilised to distinguish the two sides on broken fragments. The portion of the head below the umbel is either a simple conical or trumpet-shaped expansion of the stalk, or is a thickening sometimes cylindrical or even narrowed in its superior portion (Pl. LXXI. fig. 9). In the latter case this swollen lower portion of the head may bear a special second row of teeth, which lie parallel to the toothed margin of the umbel. Not only do the length and strength of the stalk vary greatly, but the shape of the lower portion, which is sometimes quite gradually pointed, sometimes conically truncated or even rounded off. The degree of roughness is also as variable on the lower as on the upper portion.

The gastral skeleton agrees essentially with the dermal, so that I may simply refer to the above description of the latter, and content myself with noting the principal deviations. These differences are indeed notable enough to keep us from ignoring them, as Carter has done in his otherwise excellent description of the skeletal elements in *Farrea occa*. The large gastral pentacts agree almost perfectly in shape, size, and disposition with those of the dermal skeleton. It seemed to me, however, that there was a more frequent occurrence of the remnant of the lost sixth ray in the form of a conical or rounded boss. Often enough, however, in the gastral membrane, pentacts may be seen without any trace of this remnant.

The difference between the gastral and dermal skeletons consists chiefly in the form of the clavulæ, which occur here also beside the pentacts, corresponding in number, position, and arrangement to those above described, but differing somewhat in form. In the majority of the gastral clavulæ, four or eight long, slender, more or less markedly recurved hooks or teeth are formed on the very differently shaped head portions, and produce a certain resemblance to an anchor. The head at least, and the greater part of the stalk, are destitute of those roughnesses which are so frequent in the dermal clavulæ (Pl. LXXI. figs. 8, 10; Pl. LXXII. fig. 9).

This difference in shape between gastral and dermal clavulæ, is not of course constant nor everywhere marked to the same extent. While in some specimens, and in certain regions of a single specimen, almost all the clavulæ of the gastral skeleton exhibit this anchor-like structure, and only a few provided with the flat terminal umbels occur in the dermal membrane, in other regions and in other specimens the umbel-bearing forms may

predominate, and indeed the anchor-like forms may decline to such an extent, that they are only found here and there.

I have taken special pains to try to elucidate the characters of the soft body and especially the system of chambers in those specimens which are best preserved. Neither the dermal nor the gastral membrane exhibits any special peculiarities. Where the dermal network has been in any way preserved, it exhibits meshes of variable width, sometimes very narrow as represented in Pl. LXXI. fig. 3 and Pl. LXXII. fig. 5, and sometimes so wide, that the whole rectangular region between four adjacent pentacts exhibits only one large round aperture. The gastral membrane exhibits similar relations.

In the younger portions, which are supported only by a single reticulate layer of the dictyonal framework, the chambers form a simple, or slightly folded layer of large saccular or thimble-shaped diverticula of variable size. Below the rectangular meshes of the dictyonal framework, they unite to form a wide excurrent space (Pl. LXXI. fig. 3), so that, on looking down from the gastral surface, below each mesh, one finds a large excurrent aperture. When the thickening of the wall towards the base of the stock results in a dictyonal framework of several layers, broad canals traverse this thick wall. The chambers, which are directed obliquely, then appear rather as lateral and terminal diverticula of the wide principal canals, and seem to be continuous with them without any marked boundary (Pl. LXXIII. fig. 2).

The number of chamber-wall pores varies greatly in the different regions of the body and in different specimens. The thin layer of connective substance which forms the walls of the chambers bears internally the epithelial cells, arranged in rectangular fashion as in *Euplectella*, and also united by the same lateral processes into a rectangular network. The trabecular framework which extends between the two bounding membranes and the chamber layer consists of delicate strands with fine expansions at the points of insertion and union.

In many cases the external surface of the chamber wall exhibits numerous groups of small, crowded cells, with nuclei which stain with special readiness. It is possible that these groups of six to twelve cells are concerned with reproduction; I have at least remarked their total absence in several specimens which contained numerous sperm balls at various stages. I have unfortunately found no ova or larvæ. It is true indeed that in one fragment from Sagami Bay, the subdermal trabecular space contained numerous blastulæ in some regions, but whether these belong to the *Farrea* or to some commensal, or perhaps to some quite unconnected form, it is difficult to determine, since the state of preservation of the specimen was by no means favourable. The minuteness of the larvæ (0·03 mm. in diameter) seemed, however, noteworthy.

2. *Farrea sollasii*, n. sp. (Pl. LXXIV. figs. 1–6).

On the much macerated and half-eaten skeleton of a dead Japanese *Farrea occa* (in Dr. Döderlein's collection), I found a system of dichotomous tubes about 3 cm. high, and evidently belonging to a *Farrea*, which in external appearance so closely resembled *Farrea occa* that any special description is superfluous. It is, however, at least probable that we have here the representative of another species. The difference lies especially in the structure of the discohexasters scattered in the parenchyma. They differ markedly from those of *Farrea occa*, so that I felt compelled to erect a distinct species.

I shall not enter into any detailed description of the strongly developed dictyonal framework, with its rough internal and external conical radial bosses, nor of the uncinates of various strength usually very much narrowed at the gastral extremity, nor of the dermal and gastral framework as a whole, but refer simply to the distinct representation given in Pl. LXXIV. fig. 1. The length of the anchor-hooks in many of the gastral clavulæ (Pl. LXXIV. fig. 5) is rather remarkable. It is, however, necessary to call attention to the peculiar discohexasters which occur in all parts of the dry skeleton, in more or less abundance, beside the quite isolated oxyhexasters which occur in the form constantly represented in *Farrea occa*. The basal portion of the uniformly developed rays of these discohexasters seems rather short, and divides into three long thin rather outwardly bent terminal rays, which bear on their outer ends a small transverse terminal plate, with four to eight gently recurved marginal teeth (Pl. LXXIV. fig. 6). Besides these delicate and weakly developed discohexasters, similar smaller forms here and there occur with stronger terminal rays, bearing discs without marginal teeth, and on the whole more resembling thickened knobs (Pl. LXXIV. fig. 1, left, below).

3. *Farrea vosmaeri*, n. sp. (Pl. LXXIV. figs. 7–13).

Among numerous specimens of *Farrea occa*, Carter, which Dr. Döderlein dredged in Sagami Bay, Japan, from a depth of 100 to 200 fathoms, and preserved immediately in spirit, there are some well-preserved portions of a *Farrea*, which in microscopic appearance and in the structure of the individual siliceous elements differs from *Farrea occa*, and so markedly from *Farrea sollasii*, that the erection of a distinct species seems inevitable. The spicules are very like those of *Aulodictyon woodwardii*, Sav. Kent, but they include oxyhexasters which are not represented in the latter. The saving clause must again be noted, that it is possible that the divergent spicules have been intruded from outside. As can be inferred from Pl. LXXIV. figs. 7, 10–13, neither the general structure of the dictyonal framework nor the majority of the isolated

spicules differ essentially from those of the corresponding portions in *Farrea occa*. The anchor-hooks in many of the gastral clavulæ seem to be especially long (Pl. LXXIV. fig. 12), and the hexasters are in part very divergent. Though most of the latter have a general resemblance to the oxyhexasters of *Farrea occa*, they differ from the latter in the greater thickness of their principal rays (Pl. LXXIV. fig. 8). Besides these, somewhat larger hexasters occur with weakly developed principal rays, which divide into four short S-shaped terminals, disposed in a perianth-like whorl and tipped with a small knob. (Pl. LXXIV. fig. 9).

4. *Farrea clavigera*, n. sp. (Pl. LXXV.).

Near the Banda Islands (Station 194, lat. 4° 34′ S., long. 129° 57′ 30″ E.), from a depth of 200 to 360 fathoms and volcanic mud ground, a *Farrea* was captured which in external appearance differed essentially from all hitherto described forms. This sponge forms a straight tubular stem about as broad and as long as a finger, with walls 1·5 to 2 mm. in thickness. It becomes gradually wider towards the upper end, attaining a diameter of 20 mm., and rising at right angles to a compact smooth basal expansion, which is directly attached to the solid substratum. Just above the solid base the internal lumen has a width of 3 mm., and is continued obliquely downwards into an external groove-like keel. At a height of 12 mm. the first lateral branch is given off, with a diameter of 8 mm., while further up several branches fork off in irregular distribution, in a somewhat transverse direction to the main stem. The latter seems to divide superiorly into two large branches which are unfortunately broken off. While some of the transverse tubes are broken off quite close to the main stem, others exhibit dichotomy into two very divergent branches. It is interesting that a very similar form has been described by Oscar Schmidt under the title *Farrea facunda* from among the Hexactinellids of the Bay of Mexico. It is figured in the work already referred to, pl. vii. fig. 1A.

The dictyonal framework does not vary essentially from that described in *Farrea occa*. Inferiorly it increases, on the one hand, in thickness, and on the other very markedly in the fineness of its meshes. The basal portion becomes a thick, stone-hard, very finely porous mass, in the meshes of which countless small hexacts occur, in part free, and in part fused to the adjacent framework. Isolated parenchymalia are further represented by uncinates and hexasters. The former seem to be comparatively long and narrow. Among the latter I have observed the form which occurs so abundantly in *Farrea occa*, but in much more sparse distribution. Whether a second form of hexaster, characterised by short principals and very long terminals, and occurring abundantly in some regions (Pl. LXXV. fig. 6), really belongs to this *Farrea*, or has been intruded from some other Hexactinellid, I cannot unfortunately determine with certainty.

The dermal pentacts resemble in general the corresponding dermalia of *Farrea occa*,

but exhibit more frequently than in the latter remnants of the atrophied sixth ray, persisting in the form of a protruding, rounded, more or less elongated distal tubercle. They also differ in the strong development of rounded lateral teeth on the four tangential rays (Pl. LXXV. fig. 8).

Very unique and characteristic of this species are most of the dermal clavulæ, of which the common form in *Farrea occa* has only an isolated occurrence. Two predominant forms occur, of which one exhibits a thick, short, superiorly rounded head with a central terminal papilla, bearing two parallel circlets of teeth (Pl. LXXV. fig. 3), while the other has a perfectly smooth, long, club-shaped distal end, which is not in any way sharply marked off from the stalk (Pl. LXXV. figs. 2, 5). These two forms of clavulæ are either quite irregularly distributed beside one another, or are distinctly restricted to certain regions of the sponge body, or finally disposed in alternate bundles in the manner represented in Pl. LXXV. fig. 2.

The strong pentacts of the gastral skeleton are distinguished by the large blunt remnant of the atrophied sixth ray and also by the specially large and distant teeth on the tangential rays. These teeth are not conical but rather cylindrical, and are rounded off at their ends (Pl. LXXV. fig. 8). The gastral clavulæ are all developed in anchor form, and usually possess only four strongly recurved long and narrow anchor teeth (Pl. LXXV. fig. 4).

Corresponding to the strong development of the wall in the still preserved portion of the single specimen captured, cross sections reveal a deep folding of the chamber layer. The single chambers are somewhat smaller and more irregular than in the tube of *Farrea occa* (Pl. LXXV. fig. 2), nor did the latter exhibit an equal strength of development.

Farrea sp. (?) (Pl. LXXVI. figs. 4, 5).

Among numerous macerated *Farrea* skeletons in the Challenger collection, which could not be satisfactorily identified in the absence of all isolated spicules, there was one form which, though small and crumbling, seemed worthy of more notice than could of course be given to the majority. This specimen, which is figured in Pl. LXXVI. fig. 4, essentially differs in its whole configuration from any of the hitherto here described species of *Farrea*. It has the form of a slightly convex funnel, somewhat broken at the sides, and 1 to $1\frac{1}{2}$ cm. in height. It consists of a single lattice-work layer with well-developed rectangular meshes, and with strongly developed beams which resemble those of the dictyonal framework in undoubted species of *Farrea*. I would not give so much attention to this form, if Carter and Bowerbank had not previously described and figured as species of *Farrea* certain funnel-shaped Hexactinellids, of which it is possible that some belong to the genus, though differing from the tubular type in more respects than in form. These forms are *Farrea infundibuliformis*, Carter (identical with *Farrea*

infundibularis, Carter), *Farrea gassioti*, Bowerbank, and *Farrea pocillum*, Bowerbank. The last of these three forms (*Farrea pocillum*, Bowerbank) certainly does not belong to the genus *Farrea*, as Bowerbank's figures[1] and description clearly show. On the other hand, *Farrea infundibuliformis*, Carter, and *Farrea gassioti*, Bowerbank, may quite possibly belong either to the genus *Farrea* itself or to some related genus within the family Farreidæ. I only desire to direct the attention of specialists to this funnel-shaped Farreid, for such at least the fragment figured in Pl. LXXVI. certainly is.

Subtribe II. **Scopularia** (Carter), F. E. Schulze (Pls. LXXVII.–XCVIII.).

Besides the pentact hypodermalia and hypogastralia, radially disposed scopulæ occur.

Family I. EURETIDÆ, F. E. Schulze (Pls. LXXVII.–LXXXII.).

Branched and anastomosing tubes, which either form an irregular framework with tubes of almost uniform width, or else the wall of a cup. The dictyonal framework exhibits from the very first more than one layer, so that a single layered network of strands never occurs at the ends of the tubes.

Genus 1. *Eurete* (Semper), Carter (Pls. LXXVII.–LXXIX.).

1868. Semper, Verhandl. d. Würzburg. phys.-med. Gesellsch., Sitzungb. vom July 18.
1875. Marshall, Zeitschr. f. wiss. Zool., Suppl., Bd. xxv. p. 181.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii. p. 113.
1877. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xix. p. 112.
1877. Zittel, Abhandl. d. k. baier. Akad. d. Wiss., Bd. xiii. Heft 1, p. 1.
1880. O. Schmidt, Die Spongien des Meerbusens von Mexico.

History.—In the Transactions of the Physico-Medical Society of Würzburg, 1868, there occurs, in the report of the session held on 18th July 1868, the following notice:—"Mr. Semper showed some new siliceous sponges from the Philippines. One is a new species of the genus *Hyalonema*, and another may be regarded as a type of a new genus *Eurete*." "The genus *Eurete* was established for a sponge, having the form of a coral, the cylindrical and hollow branches of which are everywhere united to one another. The wide openings at the extremities of the branches seem to be exhalent, the fine pores between the network, which constitutes the walls of the tube, are apparently inhalent. The tissue of the wall of the tube—which measures about 1 mm. in thickness—is composed of a tolerably dense network of fine siliceous tubes, which are sometimes

[1] *Proc. Zool. Soc. Lond.*, pl. xxxix. fig. 48, 1875.

fused together irregularly, though occasionally also crossing one another in a regular manner, so that a network surrounding rectangular meshes becomes formed. It seems nowhere to show actually free cross spicules, yet very frequently the cavities of the amalgamated cross fibres remain independent of one another, so that often two or three hollow spaces lying close to one another, yet not connected, are cemented together by a common siliceous mass. In these siliceous tubes the uncommonly wide cavity of the axial cord is remarkable. It is often so wide that its diameter exceeds the thickness of the wall about six times. It is to be regretted that the single specimen is much bleached and macerated, so that it is not possible to say whether the almost complete absence of all free siliceous bodies should be looked upon as a peculiarity distinguishing this genus. To judge from the structure of the tissue, this sponge probably belongs to the same genus as *Farrea occa*, Bowerbank. Since, however, only fragments of the latter are known, it is still possible that they belong to the *Euplectella cucumer*, Owen, on whose roots they were found, so that provisionally *Farrea occa* and *Eurete simplicissima*, Semper, may be regarded as distinct from one another. An accurate examination of the tissue of *Euplectella cucumer* would throw light on this question. Detailed descriptions will shortly be given in the Zeitschrift für wissenchaftliche Zoologie."

The description here promised was given by W. Marshall in 1875.[1] Marshall first confirms the general description of Semper, and calls attention to the occurrence of transverse divisional walls close beneath the orifices of some tubes. These he designates by the name of *sieve-plates*, and is inclined to regard them as indicating the regular limit of every " individual " properly so called. Of free spicules Marshall, like Semper, found but a mere trace, and he therefore concluded that even the living sponge had *none*. This view has again been definitely expressed by Marshall[2] after re-examination of Semper's original specimen.

The sponge minutely described by Carter under the name of *Eurete farreopsis*[3] was, like the majority of objects of this nature that have to be dealt with, much macerated, yet in some remnants of the dried soft parts, a number of free siliceous spicules could still be found. From Carter's minute description I make the following excerpt as being of very great importance :—" General form bush-like, composed of many tube-branches anastomosing clathrously. Branches short, thick, cylindrical, hollow, formed of a delicate, thin, reticulated wall, thickening from the growing margin towards the base or oldest part. Orifices of branches respectively circular at first, then expanded, afterwards funnel-shaped, becoming elliptical and contracted in the centre, where by the union of the approximated parts of the margin, two circular orifices are formed, which grow into two short, round, tubular branches in opposite direction, to divide again after the same

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxv. p. 181.
[2] *Mittheil. K. Zool. Mus. Dresden*, ii. p. 272.
[3] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xix. p. 122, 1877.

manner, and so on—or to anastomose with other neighbouring branches. The meshes of the reticulated tissue are subquadrangular."

"Spicules of three kinds, namely, skeleton, subskeleton and flesh spicules. Skeleton spicules *sexradiate* arms spined throughout, pointed in the smallest, inflated at the extremities in the largest specimens. Subskeleton spicules of two forms:—(1) *acerate*, straight, *fusiform*, attenuately pointed, spined throughout, spines all inclined one way, and more or less closely applied to the shaft; (2) *scopuline spicule*, consisting of a shaft and head; shaft cylindrical, abruptly pointed at the free end, quadrangularly inflated at the other, micorspined throughout, most evidently towards the free end; head consisting of four arms, respectively supported by the four angular projections at the end of the shaft, at first remaining parallel or slightly curved towards each other and then expanded; arm much thinner than the shaft, inflated globularly at the extremity, microspined throughout, especially towards the inflation, where the spines are long and inclined backwards, leaving the convexity of the inflation smooth or bald. Flesh spicule a Hexactinellid rosette, each arm bearing four capitate rays, expanded *en fleur-de-lis*, or without extended arms, the latter being reduced to a central point, from which the rays radiate in all directions so as to present a globular form."

"Vitreous fibre smooth between the knots, which are globular and spino-tuberculated all over, except where interupted by their union with the fibre, or by the projection of one or more arms of the sexradiate spicule in the form of large spines, thickened or elongated, pointed or inflated at the extremity and spinulated throughout."

According to Carter the following are the peculiarities of *Eurete farreopsis*:—"The *globular tuberculated knots* of vitreous fibre, which, with the centrally developed spine, looks like a bossed omphalic shield, and the *globular inflations* respectively at the ends of the scopuline arms very much like a 'bald head.'"

Character of the Genus.—A system of multifarious dichotomously branched and richly anastomosing tubes of approximately equal diameter, fixed to its substratum by means of several solid or hollow supports which are inferiorly expanded in a plate-like manner. The margin of these oscular openings is not attenuated as in *Farrea.* The dictyonal framework of beams forming the skeleton consists in all parts of the sponge—even in the latest formed margins of the oscular openings—of several layers, and surrounds more or less regularly formed, in many cases almost square, in others irregularly quadrangular or triangular, meshes with simple or knot-like thickened intersections. On the dermal and ventral surfaces of the framework of beams conical pegs of various length arise from the intersections, and are directed at right angles to the bounding surface.

The dermal and gastral skeletons consist of pentact hypodermalia and hypogastralia respectively, and of numerous scopulæ provided with knobbed or pointed teeth.

In the parenchyma harpoons directed at right angles to the surface and hexasters of various kinds occur in addition to simple hexacts.

1. *Eurete semperi*, n. sp. (Pl. LXXVII.).

Near the Little Ki Island (Station 192, lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.), from a depth of 140 fathoms and a blue mud ground, the trawl brought up, among numerous other Hexactinellids, that form of *Eurete* represented in Pl. LXXVII. fig. 1. It was abundantly beset with small *Actiniæ* and exhibited in spirit a dull light grey colour. Several solid basal pedestals, 5 to 8 mm. in diameter, partly united in a common basal plate, bear a system of irregular reticulated and anastomosing tubes, 8 to 15 mm. in diameter, and 1 to 2 mm. in wall's thickness. The free end is unfortunately broken off, or more or less seriously injured.

The basal pedestals are dead up to a level of about 10 mm., otherwise the stock is tolerably well preserved. The strongly developed, somewhat irregular, dictyonal framework, which only rarely exhibits square or rectangular meshes, consists of strong beams beset with a few small spines, and united in thickened, spherical, swollen nodes of intersection more or less thickly covered with strongly developed but low-set teeth (Pl. LXXVII. fig. 2). The freely projecting spherical spinose bosses on the dermal and gastral surfaces are remarkably short and stunted. In the inferior regions of the stock the meshes of the dictyonal framework are very much narrowed by numerous small apposed hexacts, which, becoming thickened and united all round, contribute to strengthening the already existing framework. The result is the formation of a firm, stony, finely porous mass. Superiorly, however, the meshes become wider. Afferent canals traversing the wall at right angles to the surface, and corresponding efferent canals are seen in the dictyonal framework as round passages which run alternately from the outer and the inner bounding surface, and either end blindly or divide into lateral twigs. The thicker the wall of the tube, the more is the canalicular system developed within the dictyonal skeleton. The free parenchymalia are represented especially by small simple regular oxyhexacts, present in extraordinary abundance, and thickly beset in every region with minute pointed tubercles, so that they appear rough even under low power (Pl. LXXVII. fig. 7). In almost any region of the dictyonal framework they become readily fused to a ray perpendicular to the surface of the framework, or to one of the thick nodes of intersection (Pl. LXXVII. fig. 8). There they become thickened by the apposition of concentric siliceous lamellæ and also unite with other adjacent strands, thus leading to the growth and thickening of the whole dictyonal skeleton. The size of these rough hexacts varies greatly, but they rarely exceed 0·17 mm. in diameter.

The uncinates, which are always disposed at right angles to the bounding surfaces,

are only sparsely present, somewhat slender in form, and thickly beset with long, closely appressed, narrow barbs.

Besides these, I find in the parenchyma, between the strands of the dictyonal framework, isolated minute discohexasters with six divergent, comparatively straight, terminal rays of equal length, on each of the six short, slender principals, which exhibit small knob-like terminal plates (Pl. LXXVII. fig. 9).

The dermal skeleton exhibits medium-sized pentacts with much thickened rough and rounded ends on the four gently incurved tangentials, a somewhat longer proximal ray also with a rough rounded off end, and lastly, a simple inconspicuous distal tubercle in place of the atrophied sixth ray. Besides these hypodermalia which are united by their tangential rays into a quadratic network, there are abundant, very characteristic—indeed specifically distinctive—dermal scopulæ in which the smooth stalk with a rough gradually pointed proximal end is expanded distally in a conical fashion, and bears four, or rarely five or six, cruciately disposed prongs. The thin stalks of these slightly divergent prongs are usually slightly bent (Pl. LXXVII. fig. 5), and less frequently straight. They are continued outwards into a smooth, spindle-shaped, thickened end, which occasionally exhibits a somewhat sharply defined point and an internal sharp edge.

The pentacts of the gastral skeleton resemble those of the dermal, but the scopulæ which occur beside them differ in some essential points from those in the dermal region. The four to six thin prong-stalks, which are curved gently outwards, bear club- or pear-shaped terminal thickenings which are thickly beset round about with short obliquely disposed barbs. Only the outermost pole of the terminal prong-swelling remains free from these minute teeth (Pl. LXXVII. figs. 6, 10).

The soft tissue exhibits here, as in all species of *Eurete*, a continuous dermal and gastral membrane with pores of very varied width, and a delicate subdermal and subgastral trabecular framework, in which the usually simple and straight afferent and efferent passages are seen as roundish canalicular spaces. The system of chambers forms a deeply, but somewhat simply folded layer of small chambers of the ordinary type, and somewhat sharply separated laterally from one another (Pl. LXXVII. fig. 2).

2. *Eurete schmidtii*, n. sp. (Pl. LXXVIII. figs. 1–6).

Among the numerous specimens of *Eurete* now at my command, there are three which agree both in their microscopic appearance, and in the minute structure of the skeletal parts. These belong to a new species which I have named *Eurete schmidtii*, in honour of the illustrious spongiologist, Professor Oscar Schmidt of Strassburg. Two of these are preserved in alcohol, and were brought home by the Challenger Expedition, having been trawled in the neighbourhood of the Philippines at Station 201,

lat. 7° 3′ N., long. 121° 48′ E., from a depth of 102 fathoms and on stony and gravelly ground. The third was bought in a dried condition by Dr. Döderlein in Enoshima.

The transverse diameter of the tolerably thick-walled tubes, which form a dense basket-work, varies between 5 and 7 mm. The oscular openings are frequently somewhat contracted on the extremity of the freely projecting, short ends of the tubes. The Japanese specimen shows one irregularly bounded basal plate, which formed a flat expansion on the stony substratum. From this plate arise the thick, partly solid, partly hollow supports of the plexus of tubes. It is probable that these relatively large basal plates have resulted from the confluence of the several basal expansions of the originally independent supports. In the case of the two Challenger specimens, one of which is represented on Pl. LXXVIII. fig. 1, the basal portion is entirely absent. On the Japanese specimen, as well as on both those from the Philippines, there were numerous small irregularly scattered *Actiniæ* with a diameter varying from 1 to 1·5 mm.

The dictyonal framework exhibits a tolerably regular structure with predominantly square meshes, smooth or but slightly spinose beams, and scarcely thickened, moderately spinose nodes of intersection (Pl. LXXVIII. fig. 2). Between the beams of the dictyonal framework small rough oxyhexacts occur in variable abundance, most plentifully in the basal region. They lie freely, or fused with single-rayed parenchymalia. In the latter case the dictyonal framework is, in several regions of the stock, further strengthened by the tolerably abundant occurrence of a second kind of parenchymalia, viz., medium-sized oxyhexasters with short principal rays, each bearing two long moderately divergent terminals (Pl. LXXVII. fig. 6). Besides these, numerous uncinates occur, which are remarkable in their structure, and to some extent also in their disposition. For while the uncinates are otherwise almost always disposed at right angles to the bounding surfaces, in this case many of them not only penetrate the wall transversely, but occur abundantly disposed obliquely or parallel to the bounding surfaces. Forms so directed are much longer than the others. Both exhibit a somewhat marked flattening on both sides. The somewhat thickly apposed pointed barbs are not uniformly distributed all round, but sometimes occur on two slightly spiral longitudinal rows on the narrow edges of the uncinate, while the two flatter surfaces remain smooth.

The pentacts of the dermal skeleton vary in size, and bear rough cylindrical rays of medium length, which are simply rounded off at the extremity. The four tangentials, which are tolerably straight, are not disposed quite at right angles to the proximal ray, but more or less inclined towards it. A knob-like protuberance represents the abortive distal ray.

Besides these pentacts there are numerous scopulæ, represented by two different forms. The less frequent form is provided with four knobbed terminal prongs, while the much more numerous second type bears, on a knob-like thickening of the inferiorly pointed stalk, two to four slightly divergent barbs, which are rather strongly developed

at the base, but gradually decrease in diameter towards the pointed extremity, and are laterally compressed like the blade of a knife, with the edge turned inwards and the back towards the exterior (Pl. LXXVIII. figs. 3, 5).

The pentacts of the gastral skeleton generally resemble those of the dermal skeleton, but more frequently exhibit a gently arched or even markedly protruding knob-like elevation in place of the undeveloped sixth ray. The scopulæ are tolerably abundant; and resemble the dermal forms of the first type. The expanded end of the posteriorly pointed stalk bears a knot-like swelling with four to five slightly diverging prongs. The slender stalk of the prongs exhibits a club-shaped extremity beset with small barbs (Pl. LXXVIII. fig. 4).

The structure of the soft parts does not differ in any essential feature from that described in *Eurete semperi*.

3. *Eurete farreopsis*, Carter (Pl. LXXIX. figs. 5–8).

The species of *Eurete* figured in Pl. LXXIX. fig. 5 is a tubular feltwork, which in several places is firmly attached to the solid substratum. The tubes have a comparatively small diameter (of 5 to 8 mm.) and only a moderate peripheral thickness. The form was obtained near the Little Ki Island (Station 192, lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.) from a depth of 129 fathoms and a blue mud ground. It was thus found in the same locality as *Eurete semperi*. In the structure of its skeletal elements it resembles very closely the *Eurete farreopsis* described by Carter in 1877,[1] and represented in a very effective figure (pl. ix. figs. 1–7). The identity of the two forms is unquestionable. The dictyonal framework, in which the square form of meshes predominates, consists of smooth or only slightly tubercled beams, and of more or less markedly thickened and roughened nodes of intersection. Simple, rough, minute oxyhexacts occur in the parenchyma, especially in the older and lower portions, and are in part fused by one ray to the general framework. Besides these, the parenchyma includes small discohexasters with terminal knobs on the four divergent, moderately long, often perianth-like, curved terminal rays, and in sparse occurrence the familiar uncinates beset round about with appressed barbs.

The dermal skeleton agrees perfectly with the gastral. The pentacts are provided on both sides with slightly curved tangential rays, somewhat rough at the rounded off extremities, and a somewhat longer straight radial, in which the narrowed, roughened, terminal portion is moderately pointed or rounded off.

Just as the dermal and gastral pentacts resemble one another, so do the peculiarly shaped scopulæ which occur beside them; but the latter are characterised by the sharp break-like bend of the terminal rays. Each of these thin bent stalks, which diverge

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xix. p. 122.

considerably after the curvature, bears a more or less sharply defined terminal knob, with a smooth apex, but with sides bearing several rows of fine recurved barbs.

4. *Eurete carteri*, n. sp. (Pl. LXXVIII. figs. 7–12).

Two specimens of *Eurete*—one of which was trawled by the Challenger Expedition in the vicinity of Little Ki Island (Station 192, lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.), at a depth of 129 fathoms and upon blue mud ground, while the other was dredged by Dr. Döderlein in Sagami Bay, Japan, at a depth of 150 fathoms—are, on account of the agreement of their structure, united into a single species which is very closely allied to *Eurete farreopsis*, Carter, from the Moluccas. I name these *Eurete carteri* in honour of the famous Nestor of spongiologists—Mr. Carter.

The Japanese specimen exhibits a narrow-meshed tubular framework which was fixed to a piece of rock by means of a few compact pedicels. The constituent tubes are from 5 to 7 mm. in breadth, and open out by means of short projecting terminal branches. In the wall of several of the tubes there are circular holes measuring from 3 to 4 mm. in width—but whether these are to be ascribed to accidental injuries, or are to be regarded as normal structural features, appears to me to be doubtful. I would lay little weight on the fact, were it not that similar circular perforations of the wall of the tube are also found in the other specimen, which is a fragment of a network of wider tubes.

The dictyonal network of beams exhibits but little regularity. The meshes are occasionally perfectly square, but are as a rule triangular. The beams are never quite smooth but are more or less richly beset with small pointed tubercles. The intersections are usually somewhat thickened, though here and there they appear but slightly differentiated. They are always thickly covered with small tubercles. The pegs which project on the dermal and gastral surfaces are tolerably thin, either conical or provided with a knob-like thickening on the extremity, and are always rough and tuberculated.

The hypodermalia and hypogastralia are rough pentacts with slightly bent transverse rays, while each is provided with a straight radial ray which varies considerably in length. The extremities of the transverse rays are as a rule somewhat swollen, but they are sometimes simply rounded. The radial ray is in most cases simply rounded at the extremity, though occasionally provided with a slight swelling.

The scopulæ of the outer skin resemble those of the gastral surface. Both possess smooth or quite insignificantly rough stalks which terminate in the parenchyma by simple rounded extremities or become slightly attenuated; on the other side, however, from four to six terminal prongs spring from a small conical thickening, and these are provided on the outer extremities with a knob-like rough swelling. The thin, usually smooth, but here and there also somewhat rough stalk of these terminal prongs is always straight or slightly bent (Pl. LXXVIII. figs. 9, 10), but it is *never* sharply dislocated like the prong

stalk in the scopulæ of *Eurete farreopsis*. The terminal knob-like thickening may, as shown in figs. 9, 10, be pear-shaped, or be more sharply differentiated from the thin stalk, so as to approach nearer to the spherical form.

The uncinates are feeble and not very long, but beset with fine barbs.

The small discohexasters which are scattered quite irregularly in the parenchyma bear, on each of their principal rays, three or four straight terminals, which are irregularly disposed, or arranged like the petals of a lily (Pl. LXXVIII. figs. 11, 12).

Moreover, at certain spots here and there, but in special abundance in the basal regions there are simple hexacts, which are either smooth or provided with scattered tubercles, and run out to fine points. These originally lie freely in the parenchyma, but subsequently amalgamate with the dictyonal framework of beams, or with one another, and so contribute to the thickening or strengthening of the continuous skeleton.

5. *Eurete marshalli*, n. sp. (Pl. LXXIX. figs. 1–4).

A species closely related to *Eurete farreopsis* and *Eurete carteri*, was found near the Little Ki Island (Station 192, lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.) at a depth of 140 fathoms, on a blue mud ground. Two specimens were obtained, both covered with small *Actiniæ*. The smaller is represented in Pl. LXXIX. fig. 1. In its smooth, or only slightly toothed strands, and thickened spinose nodes of intersection, the dictyonal framework closely resembles that of *Eurete farreopsis*. On the other hand the parenchyma includes numerous oxyhexacts with long divergent terminals (Pl. LXXIX. fig. 3) very different from the corresponding spicules in the above species. Between the beams of the dictyonal framework small simple hexacts are present, and also uncinates beset round about with slender pointed barbs; neither of these forms, however, exhibit any striking peculiarities. The spicules of the dermal and gastral skeleton are so closely alike that a separate description is quite unnecessary. The slightly curved tangential rays of the pentact hypodermalia and hypogastralia are rough at their rounded ends, and the same is true of the long proximal. The tubercle which frequently occurs as a persistent trace of the undeveloped sixth ray is usually inconspicuous. A noteworthy fact, and distinctive of this form as distinguished from *Eurete farreopsis*, is this, that the somewhat markedly divergent terminal rays of the scopulæ, which are provided with pear-shaped barbed terminal knobs, exhibit no bend or break in their thin stalks, but are quite straight throughout their entire length.

6. *Eurete bowerbankii*, n. sp. (Pl. LXXIX. figs. 9–13).

Among the Japanese specimens of *Eurete* collected by Dr. Döderlein in Sagami Bay by aid of the dredge and trawl, and well preserved in spirit, there occurs a tree-like form

with a funnel-shaped expanded principal tube, and several lateral tubes 3 mm. in breadth. The dictyonal framework of this sponge exhibits beams which have a slightly tuberculated surface and no sharply differentiated or slightly thickened crossing knots. In addition to the hypodermalia and hypogastralia, which do not differ essentially from those of *Eurete farreopsis*, scopulæ occur. These have straight, unbroken, rough terminal rays which are of a thick club- or knob-like shape. The uncinates are of various thickness, but in most cases they are quite slender, and do not always stand at right angles to the surface of the tube. Simple hexacts occur which are partly free and partly fused together in various numbers. In contrast to *Eurete carteri* and *Eurete marshalli*, the great abundance of oxyhexasters is particularly characteristic of the species. They possess simple cylindrical principal rays, which are twice as long as the four greatly diverging conical terminals, which are arranged in a cruciform manner on the extremity of each of the principals (Pl. LXXIX. fig. 13).

I shall further add a short note in regard to a species described by Semper, which presents some peculiarities worthy of notice.

Eurete simplicissima, Semper.

The beautifully developed network of tubes which Semper procured from Zebu, and established as the basis of the genus *Eurete*, has been carefully described and figured (two-thirds natural size) by Marshall.[1] This specimen was kindly lent to me for comparison by Professor Semper, but the remnant was unfortunately too utterly macerated. With the exception of some parenchymalia (oxyhexasters with long thin terminals), no free spicules were to be found. The dictyonal framework is composed of smooth or slightly spinose beams, without any marked thickening at the nodes of intersection, and exhibits so few characteristic peculiarities that it is difficult or impossible to distinguish it from that of the other species.

I am not in a position to say whether one of the species described may not be identical with *Eurete simplicissima*, Semper. It was suggested by the structure of the oxyhexasters found in the base of an attached *Actinia*-like Anthozoon, that *Eurete simplicissima* resembles my *Eurete marshalli*, which is figured in Pl. LXXIX. figs. 1 to 4. But since the dictyonal framework of this last species is provided with thickened and spinose nodes of intersection, the resemblance is not complete.

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxv., Suppl., pl. xii.

Genus 2. *Periphragella*, Marshall (Pls. LXXX., LXXXI.).

1875. Marshall, Zeitschr. f. wiss. Zool., Bd. xxv. Suppl., p. 177.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii. p. 113.

History.—Among the Hexactinellida which Marshall described in 1875 in the Zeitschrift für wissenschaftliche Zoologie, there was a cup-shaped sponge about 15 cm. in height from the Moluccas. On the lateral walls of this "there are curious tubuliform individuals, which have coalesced and communicate with one another, and are provided with a labyrinth of internal canals. They are sometimes broad and flat, sometimes tubuliform, but always very slender." Marshall has applied to this form the name *Periphragella elisæ.*

The network of siliceous beams, which is very dense beneath, but more diffuse above, presents a tolerably regular structure with permeating square meshes, and very small plain, round knobs on the surface of the beams. Of free spicules Marshall found (1) smooth hexradiate spicules; (2) simple five-rayed spicules, the unpaired principal ray being twice as long as the others; (3) small hexradiate spicules with concave terminal discs, with five circularly disposed teeth on the margin of each; (4) somewhat larger hexradiate forms in which the rays are divided about the middle of their length into from two to four pointed prongs; (5) broom-shaped spicules with a smooth shaft, on the expanded extremity of which there are four somewhat diverging clubs, whose circular terminal knobs are provided with zones of plain recurved tubercles. All these spicules occurred exclusively in the middle and upper parts of the sponge; in the base only small smooth hexradiate spicules were found between the lattice-like network of beams.

In his statement in regard to the affinities of the Hexactinellida,[1] Marshall summarised the characters of the genus *Periphragella* in the following words:—"Polyzoic, individuals conical, mouth naked, with conspicuously developed goblet-shaped pseudogasters. Spicules sometimes hexradiate or simple dentate rosettes. Broom spicules with four regular teeth. Special closing spicules for the dermal pores. Lattice-work very regular."

Periphragella elisæ, Marshall (Pl. LXXX., Pl. LXXXI.).

Among the dried Hexactinellida which Dr. Döderlein acquired in Enoshima (Japan), there were three specimens of *Periphragella elisæ*, Marshall. One of these, which is figured on Pl. LXXX. fig. 1, has the form of a slightly bent cup or funnel 15 cm. in length. This rises with a round hollow stalk of 12 mm. in diameter, from an irregularly formed basal plate from 30 to 40 mm. broad, and gradually expands upwards towards the round terminal opening, which is 50 mm, in breadth. The thin plate which directly surrounds the lumen of the funnel is continued, above the stalk region, into numerous radially disposed tubes of various width (from 3 to 15 mm. or more). These in most

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxvii. p. 113.

cases branch, lie apposed to one another, and anastomose freely. The narrow (from 2 to 4 mm. in diameter) tubular branches, which project externally, open outwards by means of simple circular terminal openings. Here and there, but especially in the neighbourhood of the upper extremity, there are also broad tubes, which are curved outwards in a trumpet- or funnel-like fashion, and terminate with a wide irregularly rounded margin.

The entire system of these simple or branched and anastomosing tubes, which pass out laterally from the central space, increases in thickness upwards, and is from 1 to 4 cm. broad. It forms a covering to the outer side of the cup, on the upper terminal margin of which a certain outward curvature exhibits the structure of the tubework. If one looks through the large terminal opening into the lumen of the cup —the gastral cavity—one sees the oval or circular inner openings of the tubes, which increase in diameter upwards, and have a radial direction.

In another specimen represented on Pl. LXXX. fig. 2, the stalk and basal plate are absent, and the axis of the cup is unbent. The greatly developed system of branched and anastomosing lateral tubes increases in extent towards the top, but is much injured and broken towards the thin margin of the cup, so that the latter are clearly marked in the figure, and disclose the transverse beams of the often very obvious square-meshed dictyonal framework.

Close above the stalk the wall of the cup measures 2·5 mm. in thickness, in the middle of the body 1·5 mm., and on the upper margin only about 1 mm., *i.e.*, the thickness the wall in the individual wall-tubes.

A third cup belonging to the same species was greatly weathered, and only its inferior part was preserved. It exhibits, like the first mentioned, a slight bending of the axis, and seems to have belonged to a very strong specimen, as it was borne upon a pedicel more than 2 cm. in thickness.

A plate-like fragment with the well-preserved soft body, from 1 to 1·5 mm. in thickness of the wall, exhibiting an irregular tubular form, and probably referable to the greatly expanded upper lateral tubes of alarge cup, occurred among fragments of *Farrea*, *Eurete*, and *Aphrocallistes*, in the materials collected by Dr. Döderlein in the Bay of Sagami, and preserved in alcohol. I have figured this piece on Pl. LXXXI. fig. 1, and have used it especially in the study of the soft parts as well as of the more minute structural relations of *Periphragella*. The beams enclosing the somewhat regular square meshes of the dictyonal framework are either quite smooth, or beset more or less richly with small simple spines. The free terminal bosses are always thickly spinose. The nodes of intersection exhibit no marked thickenings.

I have found uncinates only sparsely, and not always at right angles to the bounding surface. They vary in length and thickness, and are surrounded by barbs. The parenchyma includes a large number of scattered hexasters of two different types. Of less

frequent occurrence are the medium-sized oxyhexasters with simple principal rays of medium length, and with two to four outward bent medium-sized terminals (Pl. LXXXI. fig. 5). The terminal rays are usually twice as long as the principals which bear them. In the second place and much more abundantly, sometimes indeed remarkably crowded, are small discohexasters, with four to six simple or S-shaped, short, terminally knobbed terminal rays on each of the simple medium-sized principals (Pl. LXXXI. fig. 4). The dermal and gastral pentacts are very like one another. Both the slightly incurved tangentials and the radial ray projecting into the parenchyma are somewhat rough, and end in club-shaped, rounded, or more rarely sharpened swellings (Pl. LXXXI. fig. 8). The sixth ray is absent. Its position is either wholly unoccupied, or is marked only by a gentle elevation. Besides the pentact hypodermalia, there are a great number of dermal scopulæ, usually pushed far forward, and are generally arranged in tufts on each pentact. The shaft is rough, swollen into a club-shape at the lower end, somewhat conically expanded above. It bears four rather markedly diverging terminal rays, frequently bent somewhat outwards. Each terminal forms a club-shaped, often almost spherical, and tolerably distinct terminal portion, which gives off laterally several transverse rows of barbs, while the somewhat flattened terminal surface appears to be smooth. The thin stalk of the terminal ray is beset with very minute pointed barbs, which are also directed backwards.

The gastral scopulæ, which occur much more sparsely, have in general the same structure. The terminal rays seem to be more slender, and their terminal knob is smaller than in the dermal scopulæ.

In the character of its soft body, *Periphragella elisæ* does not essentially differ from *Eurete*. In the subdermal trabecula, in some regions, groups of small cells occur, which I regard as immature sperm-balls.

Genus 3. *Lefroyella*, Wyville Thomson (Pl. LXXXII.).

Lefroyella decora, Wyville Thomson.

History.—In Wyville Thomson's preliminary account of a part of the voyage of the Challenger Expedition, entitled The Atlantic, 1877, p. 401, we read :—" On the following day we sounded in 2500 fathoms, and on the 29th in 1075 fathoms, in sight of the Bermudas, with a bottom of coral mud. The dredge was put over and veered to 1600 fathoms. It came up at noon with the pasty mortar-like lifeless contents which we find almost constantly on the slopes of coral reefs; the lime sediment was mixed with a large proportion of the shells of Pteropods and Heteropods. Two fine specimens of a Hexactinellid sponge were hanging to the tangles, both unfortunately dead and slightly water worn. The largest specimen, which seems to be nearly complete, is 170 mm. in height, and shaped somewhat like an old fashioned tall champagne glass. It rests on a very solid

hard base of attachment, it then contracts to a kind of stem, and then gradually expands upwards to a width at the top of 40 mm. A deep cavity passes from the upper open end down to the stem-like constriction. The outer surface of the sponge is raised into spiral ridges somewhat as in *Euplectella*, and under the ridges are irregularly spiral lines of large holes. The interior of the cup presents a very remarkable character, which reminds one at once of many of the chalk Ventriculites. The inner layer is deeply fluted, thrown into a series of alternating vertical grooves and ridges, so that the outline of the cavity in a transverse section is deeply sinuous. The substance of the sponge throughout is composed of a close anastomosing network of siliceous fibres; towards the outside the network much resembles that of *Aphrocallistes;* while on the inner wall the structure is trellis-like, and the form of the meshes square and more regular. The spaces of the network are crowded with small regular Hexactinellid spicules, some free, some cemented to the continuous skeleton by an attachment of silica. For this beautiful sponge, which I have every reason to believe is undescribed, I propose the name *Lefroyella decora.* I have associated with this species the name of our kind friend, His Excellency Major-General Lefroy, C.B., F.R.S., Governor of Bermudas."

Oscar Schmidt says[1]:—"Under the name *Lefroyella decora*, W. Thomson describes a sponge dredged in the vicinity of the Bermudas in 1075 fathoms, which is very probably identical with our *Syringidium.* Since, however, even the best preserved specimen figured is greatly macerated and eroded, so that the more minute details cannot be recognised, I have deemed myself justified in regarding the sponge, from which I was able to give a description in accordance with reality, as new."

In Leuckart's Jahresbericht (edited with the co-operation of Marshall)[2] it is suggested, in reference to *Lefroyella decora*, Wyville Thomson, that this form is perhaps identical with *Periphragella elisæ.*

Lefroyella decora, Wyville Thomson (Pl. LXXXII.).

In the neighbourhood of the Bermudas Islands, the Challenger Expedition dredged several specimens of this beautiful form, but these were unfortunately completely macerated and much rubbed. One specimen, with a narrow cup-shaped basal portion (6 cm. in length, 4 in breadth above and 2 below), was dredged at Station 33 (lat. 32° 21′ 30″ N., long, 64° 35′ 55″ W.), from a depth of 435 fathoms and a coral mud ground. The other form, which Wyville Thomson himself described (see above), was found hanging to the tangles of the dredge at Station 56 (lat. 32° 8′ 45″ N., long. 46° 59′ 35″ W), and brought up from a depth of 1075 fathoms and a coral mud ground. This last specimen is represented on Pl. LXXII. fig. 1, in its natural size and from a

[1] Spongien des Meerbusens von Mexico, p. 47.
[2] Ueber die Fortschritte der wissenschaftl. Leistungen in der Naturgeschichte der Spongien, während der Jahre 1876–1879, *Archiv f. Naturgesch.*, 1883.

photograph. It has the form of a slender cup, attached to a broad basal plate, and is 12 cm. long by 4 broad in its upper portion. It is not, however, intact. Since Sir Wyville Thomson speaks of two specimens from this locality, of which the larger was 17 cm. in length, it is evident that the latter is not in the collection before me.

In Wyville Thomson's description, and in fig. 1 on Pl. LXXII., attention is directed to the oblique or transverse ridges projecting on the external surface of the cup and alternating with somewhat broader grooves. These transverse ridges consist almost wholly of a row of closely apposed and externally fused, short tubular stumps. The circular external end measures 4 to 5 mm. in breadth, and is directed radially outwards. In the grooves, on the other hand, there are numerous, irregularly arranged, round or elongated, oval openings of variable size, which lead into more deeply situated ducts.

The internal gastral surface of the cup presents another appearance. Here one observes a number of longitudinal ridges from 2 to 3 mm. in breadth, which project inwards and are separated by deep longitudinal grooves of equal breadth. Since these longitudinal ridges with arched roof extend from the lower blind end of the slender cup-shaped gastral space to the upper, and here and there part, their number gradually increases from below upwards, and in the upper broken end amounts to twenty. Each of these longitudinal ridges consists of two plates, which pass into one another at the free inner edge, and thus enclose an elongated slit-like space. Internally this is shut off from the gastral cavity by the skeletal fold referred to, while it communicates externally with those cavities and clefts which occur at the foot of the external transverse grooves. From the longitudinal furrows, however, which occur on the internal surface of the cup between the gastral ridges, there is a direct communication into the lumen of the tubular stumps which project radially on the external transverse ridges. When this is compared with the structure of the not very remotely allied *Periphragella,* it seems clear that the lateral tubular stumps of the outer transverse ridges, whose cavities communicate directly with the gastral cavity and which project radially outwards, represent the *efferent* lateral tubes of *Periphragella,* and like the large oscular terminal aperture of the whole cup serve for the exit of the water, while the apertures and cleft lying in the external transverse grooves, together with the associated, but internally closed, longitudinal ducts or slits, belong to the afferent system.

The dictyonal framework consists of smooth beams enclosing predominantly square or rectangular meshes, without thickening of the nodes of intersection. The freely projecting conuli are on the other hand beset with tubercles and teeth.

In the compact portions of the lattice-work, a few isolated spicules here and there occur, but it is, of course, doubtful whether they really belong to *Lefroyella decora* or are only intrusions. I have, therefore, simply mentioned their occurrence without giving any figure. Besides simple, smooth hexacts of small size and uncinates of medium length, there are scopulæ with four straight, terminally knobbed prongs.

As appendix to the Euretidæ I must here mention two small sponges, which in form and structure undoubtedly belong to this family, though they neither agree with any of the species described above, nor yet were sufficiently differentiated to admit of adequate and distinct specific diagnosis.

They form two small thin-walled funnels, 1 and 1½ cm. in height, fixed on a small basal plate, with a terminal aperture above, 5 to 7 mm. in width, and with several short, tubular, stump-like lateral openings. They thus appear to be young individuals from which a *Eurete* or *Periphragella* or even *Lefroyella* might quite well develop. They agree with one another so thoroughly, both in macroscopic and microscopic characters, that they unquestionably belong to the same species. They were both trawled off Little Ki Island, at Station 192, from a depth of 140 fathoms and a blue mud ground. The dictyonal framework generally resembles that of species *Eurete*. The beams are thickly beset with coarse and fine tubercles in irregular disposition, and exhibiting a distinct thickening of the nodes of intersection, and also short freely projecting conuli (Pl. LXXII. fig 4). The parenchymalia are of variable size, and lie at right angles to the two bounding surfaces. They are represented by uncinates, and by oxyhexasters with short principal rays, and rarely with two longer slightly curved terminals on each principal (Pl. LXXII. fig. 7), and also by discohexasters in which the short principals bear a number of long slightly curved terminals with marginally toothed terminal discs (Pl. LXXII. fig. 8).

The dermal skeleton consists of hypodermal pentacts, in which the four tangentials and also the radial proximal ray are at their ends somewhat roughened and slightly pointed or rounded at the tips. Beside the radial ray of these hypodermalia there lie radially directed scopulæ, in which the shaft is pointed at the inner end, while the outer exhibits a thickening with four or five slightly curved or even geniculate, thin, smooth, terminal rays, in which the club-shaped terminal knobs are equipped with barbs (Pl. LXXII. figs. 5, 6).

On the gastral surface I could only recognise pentact hypogastralia, which resemble the hypodermalia (Pl. LXXII. fig. 4).

Family II. Melittionidæ, Zittel (Pls. LXXXIII.–LXXXVI.).

Scopularia which have the form of a ramified tube or of a cup with lateral blind diverticula. The dictyonal framework forms somewhat regularly hexagonal open radial spaces. In each of these a funnel-shaped, outstretched continuation of the reticular membrane of the ciliated chambers extends across the lumen. This is covered further along the external surface by the dermal membrane and on the internal surface by the gastral, stretching flatly over the various apertures. The gastral skeleton includes no scopulæ.

Genus *Aphrocallistes*, Gray (Pls. LXXXIII.–LXXXVI.).

1858. Gray, Proc. Zool. Soc. Lond., vol. xxvi. (Ann. and Mag. Nat. Hist., ser. 3, vol. ii. p. 224) (*Aphrocallistes beatrix*).
1867. Gray, Proc. Zool. Soc. Lond., p. 492.
1868. Wyville Thomson, Ann. and Mag. Nat. Hist., ser. 4, vol. i. p. 114.
1868. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. i. p. 161.
1869. Wyville Thomson, Phil. Trans., vol. clix. p. 701.
1869. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. iii. p. 192.
1869. Bowerbank, Proc. Zool. Soc. Lond., p. 66 (75).
1870. O. Schmidt, Grundzüge einer Spongienfauna des atlant. Gebietes.
1870. Wright, Quart. Journ. Micr. Sci., vol. x. p. 77, pl. i.
1870. Kent, Monthly. Micr. Journ., vol. iv. p. 241.
1871. Gwyn Jeffreys, Proc. Roy. Inst., No. 54, p. 258 (*Aphrocallistes bocagei*).
1872. Carter, Quart. Journ. Micr. Sci., vol. xii. p. 450.
1872. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. ix. p. 442.
1873. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xii. p. 349.
1875. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xvi. p. 1.
1875. Willemoes Suhm, Zeitschr. f. wiss. Zool., Bd. xxv.
1875. Marshall, Zeitschr. f. wiss. Zool., Bd. xxv.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii.
1877. Zittel, Abhandl. d. Baier. Akad.
1877. Wyville Thomson, The Atlantic.
1878. Zittel, Zur Stammesgeschichte der Spongien.
1879. Zittel, Handbuch der Palæontologie.
1880. O. Schmidt, Spongien des Meerbusens von Mexico, p. 48.
1881. Milne-Edwards, Comptes rendus, vol. xciii. pp. 876, 931; Ann. and Mag. Nat. Hist., ser. 5, vol. ix. pp. 37–41–46.
1882. Weltner, Beiträge zur Kenntniss der Spongien.

History.—The genus *Aphrocallistes* was established by Gray in 1858,[1] for the species *Aphrocallistes beatrix*, from a skeleton obtained at Malacca, and was characterised in the following manner:—" The sponge cylindrical, tubular, branched, the end of the main tube closed with an open network formed of spicula; branches cylindrical, simple, rarely bifid, rounded and closed at the end; the inner surface of the tube with large unequal-sized concavities placed in longitudinal series, having a large roundish oscule near its lower edge. The sponge hard, close, calcareous, with uniform, close, equal, regular hexangular pores on the surface, and large round ostioles in series on the sides of the main tubes. The outer surface formed of intertangled transparent spines, which inosculate and unite with each other at their intersections, forming a hard rather brittle crust. The inner surface lined with a coat of fusiform transparent spicula, which are placed in bundles parallel to each other in the spaces between the roundish internal apertures of the crowded small superficial pores."

In his spongiological system,[2] Gray founded for this new form a special family—

[1] *Ann. and Mag. Nat. Hist.*, ser. 3, vol. ii. p. 224; *Proc. Zool. Soc. Lond.*, vol. xxvi.
[2] *Proc. Zool. Soc. Lond.*, p. 507, 1867.

the Aphrocallistidæ—which he placed in the order of the Corallispongia between the families Dactylocalycidæ and Euplectellidæ; and he characterised it as follows:—"Sponge tubular, tubes closed with a reticulate lid; parietes formed of agglutinated siliceous spicula, with round horizontal lateral pores; inner surface strengthened with clustered longitudinal bundles of elongated spicula."

The generic diagnosis of *Aphrocallistes* ran thus:—"Sponge tubular, closed with a lid, with smaller lateral tubular branches, which are generally open at the ends." The remark contained in the first description given in 1858, to the effect that the skeleton of *Aphrocallistes beatrix* is "calcareous," Gray now speaks of as a mere "slip of the pen," and particularly notifies that it should have been called "siliceous."

A figure of several of the forms of spicules, together with a portion of the reticulate framework of siliceous beams belonging to *Aphrocallistes beatrix*, occurs in Wyville Thomson's communication on the vitreous sponges,[1] where special attention is called to the peculiar spicular form, "which consists of a lengthened shaft, ending in a small expansion, from which spring four equal branches, each terminated by a little knob."

In his paper on *Holtenia*,[2] Wyville Thomson refers not only to *Aphrocallistes beatrix*, Gray, but to a second species, *Aphrocallistes bocagei*, Wright MS. (p. 713). As a very frequently occurring spicule of *Aphrocallistes* he describes a "regular six-rayed star, with the principal axis longer than the transverse rays and one half of it feathered."

In 1869[3] Bowerbank referred *Aphrocallistes beatrix*, Gray, to his genus *Iphiteon*, and named it *Iphiteon beatrix*. This generic name—*Iphiteon*—Bowerbank has, it is true, ascribed to Valenciennes, but upon no other ground, it would seem, than that he found the form in the Museum of the Jardin des Plantes, Paris, noted on the labels as *Iphiteon panicea*, Valenciennes. Bowerbank has characterised this genus by the following diagnosis (*loc. cit.*, p. 76):—"Skeleton siliceo-fibrous, fibres solid, cylindrical, reticulations symmetrical, areas rotulate, confluent."

Perceval Wright has described and figured a second species of the same genus, under the name of *Aphrocallistes bocagei*.[4] Various specimens of this form, brought from the Cape Verde Islands, were preserved in the Museum of Lisbon, in the British Museum, and in his own collection, and had also been dredged by Wyville Thomson during the "Porcupine" Expedition, off the south-west coast of Ireland, in deep water. The short but clear description given by Wright runs as follows:—"Sponge fistulous, erect, branching somewhat irregularly; skeleton siliceo fibrous, more or less symmetrically radial; radii short and stout on the outer surface of the skeleton, forming a series of hexagonal spaces, which are nearly all of the same dimensions, central umbo of the ray giving origin on its inner surface, often on both surfaces, to a long spine. These spines,

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. i. p. 123, 1868.
[2] *Phil. Trans.*, vol. clix. pp. 701–720.
[3] *Proc. Zool. Soc. Lond.*, p. 75.
[4] *Quart. Journ. Micr. Sci.*, January 1870, pp. 77–79.

generally long, sharp-pointed, sometimes knob-headed; spicules acerate, retentive, verticillately spined, attenuated, rectangulated, hexradiate, and subfusiform cylindrical, entirely spinous. Main tube closed by an irregular siliceous network, which is deeply concave. Pores and dermal system unknown."

Among the differences between *Aphrocallistes bocagei* and *Aphrocallistes beatrix* to which Wright called attention, but which hardly seemed to him to have more than a varietal significance, was the entire absence of the "porrecto multiradiate spicules" in the case of *Aphrocallistes bocagei,*—a distinction all the more essential, as these spicules were found to be quite constant in *Aphrocallistes beatrix.* As further points of distinction, he noted that "the areas forming the skeleton in *Aphrocallistes bocagei* are much more regularly hexagonal than those in *Aphrocallistes beatrix.* The spines on the bosses are very much longer in the former than in the latter species; in it, too, the central cavity is larger. The reticulated network-like lid is much more radiate in its composition than in *Aphrocallistes beatrix.* The bosses on the rays of the body skeleton are often knobbed." He also announced that Alexander Agassiz had recognised, from the description placed before him, the agreement between these and one of the sponges dredged by Count Pourtales to the south-east of Florida. This was soon afterwards confirmed by Oscar Schmidt, who examined the sponges dredged by Pourtales, and described them in his Grundzügen einer Spongien-fauna des Atlantischen Gebietes. He discovered the transversely disposed plate, described by Wright as a "reticulated network-like lid," of the wide exhalent opening of the main tube, not merely at the extremity, but also at several places in the interior of the tube, forming transverse septa.

Special attention was directed by Oscar Schmidt to certain spicules, which were very similar to the forms described by Wyville Thomson in *Aphrocallistes beatrix.* Each of the latter was provided with a straight shaft and four knobbed terminal teeth, while the former exhibited only three such knobbed terminal teeth provided with fine prickles.

In 1870 Saville Kent also found, in the sponge material obtained by him during the "Norna" Expedition, off the coasts of Spain and Portugal, *Aphrocallistes bocagei*, Wright. From his own examination he established its specific distinctness from *Aphrocallistes beatrix*, and he added, as further differential characters, that the whole skeleton is much more slender, and is wanting in that echinate aspect of the bosses and shafts of the radii, characteristic of *Aphrocallistes beatrix.* The "porrecto-multiradiate" spicules, which seem in fact to be characteristic and typical of the genus, are not wanting, as Professor Wright imagined; but there are none of the verticillate spined forms so abundant in *Aphrocallistes beatrix;* while, on the other hand, *Aphrocallistes bocagei* is at once recognised by the presence of abundant hexradiate spicula, having one extremity of the shaft profusely spinous, and accordingly bearing a close resemblance to those that occur in *Pheronema grayi.*

On the Portuguese coast Gwyn Jeffreys also found *Aphrocallistes bocagei*.

Carter, in his system of the Hexactinellidæ,[1] unites the characters which are common to the two then known species of *Aphrocallistes* in the following manner:—"Species tubular branched, branches closed at their free extremities, wall thick, formed of polyhedrally reticulated fibre possessing a scopuline shaft."

Of *Aphrocallistes beatrix*, Gray, he says:—"Rosette (small) with elongated shaft-like axis, many-rayed, rays straight, pointed or capitate, thorn-like chiefly situated in the middle and at the terminations of the shaft, arranged more or less verticillately; or (large) with microspined rays slightly curved and not capitate. Scopuline shaft headed with four rays of equal length, slightly everted, microspined, and terminating in small globular heads."

With respect to *Aphrocallistes bocagei*, Wright, on the other hand, he notes the following as peculiar:—"Rosette many-rayed; rays of equal length, straight, capitate; or with long shaft-like axis, like that of the small form in *Aphrocallistes beatrix*, with or without heads.

"Scopuline shaft headed with four rays of equal length flexed outwards, *en fleur-de-lis*, microspined, and each terminating in a large conical end."

In the more minute description[2] given of the two species, which are especially related by the form of the spicules, Carter notes the following different spicular forms as being characteristic of *Aphrocallistes bocagei*:—

(1) "Linear fusiform spicules with inflated centre and extremities.

(2) "More delicate linear fusiform spicules, spined throughout, all the spines being in the same direction.

(3) "Hexradiate spicules whose arms are more or less unequal in length, five being smooth at the commencement and conically inflated and spined at the termination, and the sixth spined, *feather-like*, rounded, the spines increasing in length from the fixed end to the free.

(4) "Scopuline spicules, consisting of a long shaft and four rays terminating in conical heads surrounded by recurved spines.

(5) "Rosettes with five-rayed capitate arms.

(6) "The same rosettes with the axis stretched out linearly, shaft-like, and the rays arranged round it more or less spirally.

(7) "The same rosettes, with the rays of the shaft more confined to its centre and all simple (that is, not capitate, but pointed)."

In *Aphrocallistes beatrix*, Carter found the spicules generally similar to those in *Aphrocallistes bocagei*, yet some forms exhibited typical differences, namely, "the hexradiate spicules whose pointed arms are sparsely and irregularly covered throughout with smooth spines curved outwards: scopuline spicules whose four rays were quad-

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 359.

[2] *Loc. cit.*, pp. 449–452.

rangularly based on a hand-like expansion of the end of the shaft; a straight large shaft more or less beset with long thorn-like spines, most numerous towards the centre where they are vertical, and at the extremities where they are divergent, each slightly curved and microspined; and a smaller kind in which the rays are straight smooth and capitate."

In 1875, in his Classification of the Spongida,[1] Carter erected within the family of the Vitreohexactinellida a special group—the Scopulifera—in which he noted, as type, *Aphrocallistes bocagei*, Wright.

Marshall (1876)[2] ranked the genus *Aphrocallistes* in his group of Pleionacidæ, and characterised it in the following words:—" Polyzoic, walls with prismatic anastomosing radial tubes; individuals more or less tubular or ball-shaped, astomate, arranged into groups by partition walls. Framework-tissue possessing an apparent regularity. Spicules do not throughout constitute the groundwork of the siliceous beams. The latter are often strangely bent."

Zittel[3] (1877) based his family Mellitionidæ on the genera *Aphrocallistes*, Gray *Fieldingia*, Saville Kent, *Stauronema*, Sollas, and noted the following characters:— "Sponge body branched, spherical or plate-like. Wall completely perforated by numerous tubular water canals and thus divided into honeycomb-like chambers. Skeletal spicules with thick intersections. Surface (naked? or) overspread by a delicate meshed or porous siliceous skin, which also covers the openings of the canals. Root absent."

Oscar Schmidt found *Aphrocallistes* abundantly among the sponges of the Gulf of Mexico.[4] He believed that the peculiar structure of the six-sided prismatic parietal meshwork could be explained by a modification of the fundamental hexradiate spicules—in which all the six rays do not cross at an angle of 90°, but two at an angle of 120°. He compares the lattice-like retiform transverse walls to the sieve-plate of *Euplectella* and suggests that they had been formed during pauses in the growth. The shaft provided with prongs on both ends and on the middle, which was proposed as a characteristic feature of the species *Aphrocallistes beatrix*, O. Schmidt declares to be an accidentally intruded element, and expresses the belief that this species is not specifically distinct from *Aphrocallistes bocagei*.

During the "Porcupine" Expedition a cup-shaped sponge fragment, $1\frac{1}{2}$ cm. in height, was dredged off the south-west coast of Spain from 1095 fathoms. This formed the swollen base of a Hexactinellid and was carefully described by Duncan in 1881[5] as a new species of *Aphrocallistes*. If this sponge belongs to the genus *Aphrocallistes*—which, however, according to Duncan's description of the continuous skeletal framework, can

[1] *Ann. and Mag., Nat. Hist.*, ser. 4, vol. xvi. p. 199.
[2] *Zeitschr. f. wiss. Zool.*, Bd. xxvii. p. 124.
[3] Studien über fossile Spongien, *Abhandl. d. baier. Akad.*, ii., vol. xxii., div. 1. p. 36.
[4] Spongien des Meerbusens von Mexico, 1879-80, p. 48.
[5] *Journ. Linn. Soc. Lond.*, vol. xv. pp. 324–328.

hardly be regarded as certain—it would represent, to judge from the peculiarity of the isolated spicules, a new species differing at once from *Aphrocallistes bocagei* and *Aphrocallistes beatrix.*

According to the report of Milne-Edwards,[1] *Aphrocallistes bocagei* was also dredged by the French "Travailleur" Expedition in the Atlantic Ocean, off the coasts of France and Portugal.

After Zittel, in his Studies on the Hexactinellida,[2] had mentioned that in the living species of *Aphrocallistes* a very delicate framework extended over the outer surface and the branches of the canals, Weltner described[3] (1882) a continuous covering both on the inner side and outer side of *Aphrocallistes bocagei.* In the case of the outer surface he noted the presence of a delicate covering with large inhalent pores, which passed into the characteristic parietal meshes and also spread over the ostia on the inner surface. The outer membrane contained hexradiate spicules with an externally projecting fir-tree-like ray and forming a regular meshwork; in the inner lay "the characteristic *Aphrocallistes* rosettes, the rod-like spicule (thorn spicule), and the greatly reduced form which, though only exhibiting four medium knobs, was yet recognisable as hexradiate, and lastly, a large well-developed hexradiate form which is often fused to the parietal skeleton." Moreover Weltner observed in his specimen "a third plasma layer between these coverings of the outer and inner surfaces in the interior of the meshes (canals). This was for the most part well preserved and was interrupted only in the middle, while it was continued inwards to form an outer covering for the cavity of the sponge. In it the free spicules of the internal covering were but seldom met with, although it stood in manifold connection with the latter by means of plasma-threads. This third layer," continues Weltner, "may indeed be an artificial product. I would not, however, leave it unnoticed merely on that account, because it seemed to me to show that the free spicules (flesh spicule) do not as a rule extend into the interior of the plasma."

Character of the Genus.—The wall of the cup- or tube-like body is supported by the honeycomb-like framework of the dictyonal skeleton. The radial canals which traverse it, and are from 1 to 2 mm. in breadth, appear almost regularly hexagonal and prismatic. The septa between the latter form a network of beams, with irregular but predominantly three-sided meshes, from the margins and surfaces of which conical pegs project, which are sometimes swollen and knob-like at their extremities. Where three such bounding plates meet laterally the networks of beams usually form three-sided prismatic interspaces, and thus the margins of the six-sided prismatic canals or honeycomb-like mesh-spaces become somewhat truncate or rounded.

The strongly developed reticulate dermal membrane is continued without inter-

[1] *Comptes rendus*, 1881, vol. xciii. pp. 876–931; *Ann. and Mag. Nat. Hist.*, vol. ix. p. 46.
[2] *Abhandl. d. baier. Akad.*, 1877, p. 49.
[3] Zur Kenntniss der Spongien, 1882, p. 32.

ruption over the whole outer surface of the sponge, and extends over the external openings of all the prismatic mesh-spaces. In like manner the gastral membrane, which has a perfectly similar structure, extends internally parallel to the former, and covers the inner openings of the prismatic honeycomb-like meshes. Between the two perforated bounding membranes a fine skin extends deeply folded in funnel-shaped fashion; this forms a continuation of the wall of the chambers, which are shaped like the finger of a glove, and lie around and open into the common central space. The latter is provided with an internal large exhalent orifice. This remarkable funnel-shaped expansion of the chamber wall may be supposed to have arisen by amalgamation of some specially large external chambers whose dividing walls projected to some extent even into the excurrent central space (Pl. LXXXIV. fig. 1; Pl. LXXXVI. fig. 2).

The dermal skeleton consists of hexacts, in which each of the projecting outer rays has usually a tree-like appearance, though sometimes reduced to a prickly peg or knob, or even in many cases to a small tubercle, so that finally the spicule in question is no longer to be regarded as hexact but as pentact. Besides these dermal hexacts or pentacts scopulæ with knobbed or pointed terminal rays also occur.

The gastral skeleton consists of diacts which are completely enclosed in the gastral membrane.

Among the loose parenchymalia, there are present in addition to the uncinates which project at right angles to the outer surface, small hexacts and hexasters of various kinds, in variable abundance and irregular distribution.

It is doubtful whether *Aphrocallistes beatrix*, Gray, and *Aphrocallistes bocagei*, Wright, are distinguished by sufficiently marked and sufficiently constant peculiarities to be regarded as distinct species. On the other hand, the new forms which, on account of their figure, I have named *Aphrocallistes vastus* and *Aphrocallistes tubulosus*, I regard as sharply defined "good species."

1. *Aphrocallistes beatrix*, Gray (Pl. LXXXIV. figs. 9, 10).

Since I had an opportunity of examining in the British Museum the original specimen from Malacca on which this species was established by Gray in 1858, I can, in the first place, bear testimony to the correctness of Gray's description and figures of the microscopic structure, and can also confirm those of Wyville Thomson, Bowerbank, and Carter, in regard to the minute structure of the dictyonal framework and the isolated spicules. I may, therefore, refer the reader to these representations.

Among the comparatively insignificant, and hardly qualitative distinctions which have been noted in regard to the microscopic structure of this form as compared with that first described by Perceval Wright (in 1870) from the Atlantic basin, special emphasis is laid on a spicular form which has been spoken of by all observers since Wyville

Thomson as characteristic of the species *Aphrocallistes beatrix*, Gray. This, which has been figured by me in Pl. LXXXIV. figs. 9, 10, occurs irregularly scattered in great numbers throughout the whole parenchyma. While the one axis of the spicule has two rays greatly prolonged, and while each of these two long rays divides into four diverging, pointed terminals, the rays of the two other axes, which cross the first in the middle, remain simple short principals, which end in sharp points. The entire form may be therefore described as a longitudinally extended oxyhexaster, in which the four short principal rays remain undivided, while each of the principals of the long axis, which are sometimes provided with lateral prickles, divides into four diverging, pointed terminals.

Since parenchymalia of this kind are not found in any other form of *Aphrocallistes*, it becomes possible to determine the separation of this form as a distinct species; I must, however, draw attention to the fact that in *Aphrocallistes bocagei*, which is also very similar in external appearance, I found widely scattered parenchymal oxyhexasters, and similar forms were also figured by Oscar Schmidt in the Spongien des Meerbusens von Mexico (pl. vi. fig. 3). They do not indeed completely agree with the above peculiar spicules, but they approach them, and evidence at least a close affinity between the two forms. The view which Oscar Schmidt has expressed,[1] to the effect that the spicule which is characteristic of *Aphrocallistes beatrix* is an accidentally introduced foreign element I cannot accept.

For purposes of comparison with the other species of the genus *Aphrocallistes* more carefully described below, I will here give a short summary of the most important microscopic skeletal characters, based upon my examination of the original specimen of *Aphrocallistes beatrix*, Gray.

The dictyonal framework is formed, as represented by Wyville Thomson[2] and by Bowerbank,[3] of a tolerably irregular, narrow-meshed network with strongly thickened crossing knots. The beams are almost entirely and more or less thickly beset with small tubercles, but these tubercles are stronger and more abundant on the spherical nodes of intersection, and on each of the strong conical pegs which project freely both on the dermal and gastral surfaces, and also in the interior of the radial prismatic mesh-spaces. The pegs, projecting into the lumen of the mesh-spaces, seldom stand exactly at right angles to the surface of the reticulate partition from which they spring, but are directed obliquely inwards towards the gastral cavity of the entire sponge. The middle portion of all the septa between adjoining prismatic radial canals consists only of a single layer of irregularly fused hexacts, and an irregularly triangular prismatic interspace is formed where three such septa meet.

The dermal skeleton consists of delicate hexacts in which the distal ray bears numerous narrow, curved, fir-tree-like, lateral prickles, while the five other straight

[1] Spongien des Meerbusens von Mexico, p. 50.
[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. i. p. 123.
[3] *Proc. Zool. Soc. Lond.*, 1869, pl. xxi. figs. 2–4.

and similar pointed rays are beset only with short lateral prongs. Besides these hexacts, which form with one another a quadrate dermal lattice-work, the dermal skeleton contains numerous scopulæ with their four or five knobbed prongs at right angles to the surface, while the long slender smooth stalk runs out to a point.

In the case of the gastral skeleton unfortunately nothing certain could be discovered in the small dried fragment at my disposal; on the other hand, the loose parenchymalia were well preserved in great numbers. There were numerous uncinates arranged at right angles to the bounding surface, and therefore parallel to the radial prismatic canals. The greatest breadth of these does not occur at the middle, but in their outer third part, while the attenuated gastral extremity gradually runs out to a fine point. The thin pointed barbs of the uncinates are tolerably densely apposed. The peculiar elongated oxyhexasters, which have already been described, occur scattered irregularly and in great numbers throughout the whole parenchyma.

2. *Aphrocallistes bocagei*, Wright (Pl. LXXXIII.; Pl. LXXXIV. figs. 1–8).

Both among the Hexactinellida of the Challenger Expedition and among the others purchased by Dr. Döderlein in Enoshima, there are numerous representatives of this form. Some of these are well preserved in alcohol. The fully developed typical form is a tube gradually widening upwards, with numerous radial glove-finger-like swellings on the lateral walls. The axis of the entire tube, which may attain a length of 20 cm. or more, exhibits as a rule a slight curvature. The inferior extremity, which is firmly attached to the substratum, has the form of a small cup, the wall of which shows diverticulum-like swellings only a few mm. above the basal plate, which is from 3 to 5 mm. in breadth. These are at first quite low, but further upwards they gradually increase in length, and finally attain a length of 5 cm. or more. The breadth of these diverticula, which always end blindly, measures on the under end of the tube in most cases only from 3 to 5 mm., but gradually increases in the middle and upper parts to a diameter varying from 1 to 2 cm. Very frequently much elongated diverticula occur here and there at a short distance above the base. These are bent obliquely downwards, reach the firm substratum or some laterally adjacent solid body, and become supports for the entire sponge (Pl. LXXXIII. fig. 1). In many cases the diverticula are arranged in more or less longitudinal rows, which in the inferior part of the entire tube are usually four in number and arranged in a cruciate manner. Superiorly this arrangement becomes indistinct or is no longer to be seen. A well-marked whorled disposition of the diverticula I have not been able to observe; on the other hand, I now and again saw certain variations from the normal conditions which are perhaps of importance as to the relation of this form to the others which, though separated off as distinct species, are at the same time closely related forms. On the one hand, cases are not unfrequent in which a lateral

communication is established between two or more adjoining diverticula, while they are united at the base into a common simple tube or are in open connection throughout their length. If this union occurs between the diverticula belonging to the longitudinal row, it may result in extreme cases in the formation of a longitudinal fold, on which the individual diverticula are only indicated as short boss-like swellings. On the other hand, the long diverticula which occur here and there are sometimes forked, and in this there lies the tendency to form branches.

Where the upper terminal opening with its natural margin is preserved quite uninjured it is closed, just as in *Aphrocallistes beatrix*, Gray, by a transversely stretched narrow meshed lattice-like plate. The latter is usually somewhat concavely incurved and becomes united to the honeycomb-like lateral wall in a compact, somewhat tuberculate margin. As already reported by Oscar Schmidt and Marshall, several such thin lattice-like transverse partitions usually occur in the interior of the tube, but I would call attention to some points of distinction between these internal diaphragms and the terminal sieve-plate of other Hexactinellids. While the narrow-meshed terminal sieve-plate of other Hexactinellids is united all round to the body-wall so that (apart from the sieve-like meshes) a complete closure of the tube results, in this case, a semicircular marginal portion of the internal diaphragms remains unclosed wherever a lateral diverticulum opens into the large lumen of the tube (Pl. LXXXIII. fig. 2). With regard to the occurrence, number, and arrangement of these transverse septa I have found great differences. While some specimens well preserved in other respects possess, apart from the terminal plate, no trace of septa, others show three or more internal diaphragms, but no constant relation to the whorls of diverticula can be recognised, so as to suggest the reduction of the entire tube to series of metameres. I regard it as most probable that during the growth of the tube a temporary provisional occlusion is effected by a transverse sieve-net, and that only after growth has ceased is a terminal regularly constructed lattice-work formed which entirely closes the lumen. While the latter consists of tolerably similar thick round beams, varying from 0·3 to 0·5 mm. in diameter, which surround rounded polygonal meshes of tolerably uniform size, and while freely terminating rays only project here and there into the lumen of the meshes, the transverse septa in the interior of the tube have a somewhat different character, inasmuch as they consist of beams of very various thickness which meet one another to form a network at very diverse angles, in which the mesh-spaces are not rounded but have sharp angles (Pl. LXXXIII. fig. 2).

The microscopic structure of *Aphrocallistes bocagei* agrees essentially with that of the corresponding skeletal parts of *Aphrocallistes beatrix*, as represented by Bowerbank in his excellent figures.[1] The dense network of beams which forms the dividing septa of the six-sided prismatic meshes of the wall consists, as in the case of every dictyonal Hexactinellid framework, exclusively of amalgamated hexacts. These do not

[1] *Proc. Zool. Soc. Lond.*, 1869, pl. xxi. figs. 2–4, and pl. xxii. fig. 2.

however by any means form a regular lattice-like framework with cubical mesh-spaces. A framework with predominantly three-sided meshes is in fact formed, on the one hand by the diversion of some rays from their original position at right angles to one another, on the other hand by quite irregular fusion of the rays of adjacent hexacts. In older portions these meshes appear distinctly compressed and rounded. The surface of the beams may be completely smooth, or may be roughened by the development of more or less numerous small pointed tubercles. The pegs projecting outwards towards the dermal membrane, or inwards towards the gastral membrane, are always beset with numerous tubercles and are frequently swollen in a knob-like manner. While the freely projecting dermal pegs are usually straight, that is to say, usually stand at right angles to the surface, the projecting pegs on the gastral side are found to be mostly incurved or thickened into short knobs (Pl. LXXXIV. fig. 1). The ends of the free rays of the dictyonalia which project from the surface of the septa into the lumen of the meshes also exhibit rough conical pegs which are seldom directed quite at right angles to the wall of the canal, but project as a rule obliquely.

The dermal skeleton consists of hexacts which form a regular quadrate network and are provided with a fir-tree-like distal ray (Pl. LXXXIV. fig. 8), and very variously formed scopulæ. The four equally long transverse rays, as well as the usually distinctly shorter proximal ray of the dermal hexacts, are either smooth or somewhat rough on the truncated extremities.

In the dermal scopulæ I observe that the shaft, which is of variable length, runs out at the inner extremity to a point, while the outer extremity, which is moderately swollen, or more rarely provided with a knot-like thickening, gives off four (more seldom three or five) prongs which either terminate in a point or are provided with a knob-like or club-like terminal expansion. Both on the pointed extremities and also on the terminal clubs or knobs small lateral barbs usually occur (Pl. LXXXIV. figs. 4, 5). The branches of most of the scopulæ possess the usual length of about 0·07 mm. Scopulæ also occur here and there which have the branches twice as long, and either terminate in points with small smooth knobs, or are beset beneath the extremity with small barbs (Pl. LXXXIV. figs. 3, 5).

In contrast to the Dictyonina hitherto described, the *gastral skeleton* of *Aphrocallistes bocagei* differs very essentially from the dermal. On the surface of the gastral wall I find neither hexacts nor pentacts, nor any trace of scopulæ, but only diacts of variable length, more or less rough, sometimes even pronged, with rounded extremities and central knots variously developed. These diacts lie properly in the gastral membrane, but they also extend into the subgastral space, and seem not unfrequently to fuse with the projecting, but frequently incurved and club-like swollen pegs of the dictyonal framework.

The loose parenchymalia include the uncinates, which are disposed at right angles to the bounding surface, and vary greatly in length and strength. The inner extremity

is frequently very feebly developed (Pl. LXXXIV. fig. 2). In addition to the uncinates, the parenchyma contains hexasters of various form and most irregular distribution. Sometimes one has to search long for one of these hexasters in a section, while in other cases the whole preparation appears to be permeated by them. Perfectly regular oxyhexasters, in which each of the principals runs out into four strong and moderately long, diverging, secondary rays, are comparatively rare. Usually one finds one or more principal rays terminating in simple points, while others run out into three or four terminal rays. In another frequent form the two principal rays belonging to one axis are very strongly developed, and divide into four strong, diverging terminals, while the four remaining rays, which are cruciately disposed, and belong to the two other axes, run out into perfectly simple points, or are only partially divided into two terminal rays (Pl. LXXXIV. fig. 7). These latter spicules seem to be related to the forms characteristic of *Aphrocallistes beatrix*, Gray, and represented in Pl. LXXXIV. figs. 9, 10, while, on the other hand, small discohexasters sometimes occur, which agree in form and size with certain discohexasters, which occur very frequently in *Aphrocallistes vastus*. These have a diameter of 0·03 mm., and each of the short principal rays bears four to six somewhat curved diverging terminals, each of which is tipped by a small end plate, or merely by a spherical terminal knob (Pl. LXXXV. figs. 8, 9).

In regard to the soft parts, I may state that the structure of the dermal and gastral membrane hardly varies from the ordinary Hexactinellid type, and the same may be said of the trabecular network which extends between these two membranes and the chamber layer. It is different, however, with the chamber layer itself. The most important peculiarity has been already referred to in the generic diagnosis; it claims, however, more attention, especially since I was able to investigate carefully some comparatively well-preserved specimens.

In each of the honeycomb-like hexagonal spaces, which are quite open on both sides in the macerated skeleton, and penetrate the wall in a radial direction, there is a peculiar system of chambers, which opens on the gastral surface through a single wide round aperture above the lattice-work of the gastral membrane. Into the wide, canalicular space above this aperture there open laterally a number of thimble-shaped chambers of medium size, in the form of simple, closely-apposed diverticula, while from the dermal surface, three to five large blind diverticula also open into the same. These latter diverticula closely surround the wall of the tubular skeletal space, and are laterally so closely apposed to one another, that they form between them a wide, median, funnel-shaped space. The inner wall of the large diverticula which surround this funnel-shaped space is simply smooth, while their external wall adjacent to the surrounding skeleton is distended into chamber-like diverticula, just as we previously saw on the surface of the wide general excurrent space (Pl. LXXXIV. fig. 1). In this way a funnel-shaped membrana reticularis is so stretched in the hexagonal honeycomb space, that the

circular incurrent aperture of the funnel lies under the porous dermal membrane, while the blind pointed apex lies somewhat in the middle of the space, and turned towards the gastral membrane.

While a section at right angles through the wall, which shows longitudinal sections of the radial canals, exhibits the funnels in longitudinal or lateral section, that is to say, affords a lateral view of a chamber system (Pl. LXXXIV. fig. 1), a view from the dermal skeleton reveals in each of the hexagonal spaces, on the inner surface of the skeletal enclosure, a circle of chambers which surround a simple, central, funnel-shaped, space (Pl. LXXXIII. fig. 4), and a view from the gastral surface into the wide, excurrent tube, shows the septa which arise by the coalescence of the large diverticula forming the funnel (Pl. LXXXIII. fig. 3).

3. *Aphrocallistes vastus*, n. sp. (Pl. LXXXV.).

The specimen represented on Pl. LXXXV. fig. 1, in its natural size, was collected by Dr. Döderlein in the Sagami Bay (Japan), from a depth of 180 fathoms. There was also a small fragment firmly fixed to a Coral, and apparently of similar structure, probably belonging to the same specimen. They represent parts of the lateral wall of a large cup. Instead of the glove-finger-like sacculations which occur in *Aphrocallistes beatrix* and *Aphrocallistes bocagei*, there is here a simple folding of the wall. Whether the tolerably irregular, bulging folds, which are here and there attached to the Coral branch were directed longitudinally or transversely to the axis of the entire cup could not be certainly determined, though I am inclined to believe that they were longitudinal. In this connection it is interesting that in another specimen of *Aphrocallistes bocagei*, bought in Enosima by Dr. Gottsche, an indication of the longitudinal folding of the cup-wall could be recognised. A trace of the same is also to be observed in the figure of *Aphrocallistes beatrix* given by Gray.

Since the thickness of the cup wall amounts to 5 mm., the mesh spaces, which are about 1 mm. in width, have become *canals*, which penetrate the wall transversely in a radial direction. The dermal membrane, which is still clearly visible in these dried specimens, extends in the form of a delicate skin over the whole outer surface. With a lens one can recognise a fine quadrate lattice-work formed of apposed dermalia. A quadrate lattice-like network of this kind is indeed entirely absent on the inner side of the partially-preserved gastral membrane, which has rather an irregular streaky appearance.

A more accurate examination of the dictyonal framework of the septa between the radial six-sided prismatic canals, shows that it consists of a single-layered network, with meshes predominantly three- or four-sided. The beams of the network bear rays directed at right angles or obliquely to the dermal surface, and projecting freely

into the lumen of the canals. From an examination of the often very obviously marked axial canals, it may be seen that the rays of adjacent dictyonalia are partly fused in the familiar longitudinal fashion (somewhat as in *Farrea*), partly in a more irregular arrangement, crossing one another arbitrarily, or connected at the intersections. Sometimes all the six rays are concerned in the formation of the network, which lies approximately in one plane—an arrangement which is obviously only possible through the great curvature of some rays. Usually, however, one ray is bent at right angles or obliquely inwards, and is provided with a free point, which projects into the canals on either side. Where the margins of three adjacent canals meet one another, the lattice-like networks are slightly separated, and an irregular interspace is thus formed.

As in *Aphrocallistes bocagei*, the dermal marginal pegs of the dictyonal framework stand at right angles to the dermal membrane, while the longer gastral marginal pegs are in part curved inwards. The pegs on the inner surface sometimes project obliquely towards the dermal surface into the lumen of the canals, and are sometimes applied quite close to the surface of the wall, but the free tuberculated end is always directed outwards towards the dermal membrane.

The beams of the meshwork often appear almost entirely smooth, while in other cases they are more or less richly beset with small tubercles. The freely projecting pegs all exhibit a rough or tubercled surface.

The dermal skeleton is distinguished by the strong development of the distal fir-tree-like ray of the dermal hexacts. This is richly pronged and more bushy than in the other species of the *Aphrocallistes*. The numerous scopulæ, which are present in the dermal skeleton, exhibit a shaft which runs to a point beneath, and forks externally into two, more rarely into three branches, after forming a simple expansion or an annular thickening. The branches are rough on their outer extremities, and terminate either in a simple rounded manner (Pl. LXXXV. fig. 7), or in a very slight knob-like thickening.

In the gastral membrane, as in *Aphrocallistes bocagei*, the hexacts are replaced by simple, straight, rough or pronged diacts of variable length, with rounded extremities and central knots (Pl. LXXXV. fig. 6); pin-like monacts are also scattered here and there (Pl. LXXXV. fig. 10). Whether the scopulæ, which are entirely absent in the gastral skeleton of *Aphrocallistes bocagei*, occur in the present instance remains doubtful. It is true that in the dried specimen and on the inner side of the cup-wall scopulæ occur which, like the dermal, consist of a terminally pointed shaft, and of two, more rarely three knobbed and externally roughened branches, but I am not sure that these are not subsequent extrinsic intrusions.

The uncinates are distinguished by their length and also by the fact that their greatest dilatation usually lies much nearer the dermal than the gastral extremity. This latter appears much more slender, and usually runs out into a smooth (Pl. LXXXV. fig. 2) point, which is less frequently beset with lateral prongs. It is important to note

that the irregularly scattered loose parenchymal hexasters, which are present in large numbers, all bear terminal rays the ends of which are knobbed or provided with small thick transverse discs (Pl. LXXXV. figs. 3, 5, 8, 9). The diameter of these discohexasters varies from 0·08 to 0·03 mm. The principal rays remain, as a rule, uniformly short and crowded, but the two rays of one axis are often greatly prolonged in comparison with the others, and it is just in such cases that the latter usually remain simple (Pl. LXXXV. fig. 5), while the former become divided into two to four terminal rays.

4. *Aphrocallistes ramosus*, n. sp. (Pl. LXXXVI.).

Both among the sponges of the Challenger Expedition and among the Hexactinellida dredged by Dr. Döderlein in the Sagami Bay, there are dichotomously branched round tubes from 5 to 10 cm. in height, which are only from 3 to 4 mm. broad at the base, but become gradually wider in the upper branches, and finally open out by cup-shaped lateral and terminal branches from 8 to 10 mm. in width. The specimen represented from a photograph in Pl. LXXXVI. fig. 1, in its natural size, was obtained from the Philippines (Station 210 of the Challenger Expedition, lat. 9° 26′ N., long. 123° 45′ E.), from a depth of 375 fathoms and a blue mud ground.

The tube wall consists of the same honeycomb-like framework of six-sided meshes or prismatic radial tubes, as in the cup-wall of the other species of *Aphrocallistes;* and the microscopic examination shows that the minute structure of the meshes or prismatic septa does not differ essentially from that already described.

The tolerably smooth network of beams, which is only here and there provided with delicate tubercles consists of irregularly fused hexacts, and exhibits predominantly triangular narrow meshes. While the conical pegs on the dermal side run out to simple points, and are directed at right angles to the bounding surface, the terminal pegs on the gastral surface are elongated, provided with a rough pear-shaped end-swelling, and are frequently obliquely directed or somewhat curved round. The conical pegs projecting from the surface of the network of beams into the lumen of the radial tubes are directed obliquely outwards, that is to say, towards the dermal surface.

In the dermal skeleton, hexacts occur with a very variously developed distal ray, which is sometimes quite fir-tree-like (Pl. LXXXVI. fig. 8), sometimes club-like with lateral prongs (Pl. LXXXVI. fig. 4), sometimes simply rod-like or pear-shaped, or even quite rudimentary and knob-like (Pl. LXXXVI. fig. 3). The proximal ray equals or usually exceeds the four cruciately disposed transverse rays in length. More rarely it is shorter than the others, which often exhibit an externally convex curvature (Pl. LXXXVI. fig. 2) Besides the dermal hexacts, numerous dermal scopulæ occur. These present a smooth, pointed, or terminally rounded stalk, and the outer expansion bears

slender diverging branches, each provided with a pear-shaped barbed terminal swelling. The branch stalks are smooth or rough, and either straight or uniformly curved towards the exterior, or occasionally slightly flexuous (Pl. LXXXVI. figs. 5, 9). This seems to vary according to habitat, but also according to the individual.

The gastral skeleton consists exclusively of long rod-like diacts, which are rough throughout or terminally, and are provided with a central node of intersection. Their extremities, which are embedded in the gastral membrane, are simply rounded or slightly swollen. Of gastral hexacts or scopulæ I have found no trace.

The uncinates of the parenchyma vary greatly in length and form. Sometimes the greatest breadth occurs just about the middle, sometimes nearer the outer extremity; sometimes the barbs are densely crowded, sometimes more widely disposed, and so on.

The numerous irregularly scattered hexasters are, on the one hand, oxyhexasters with a variable number of terminal rays, which are not unfrequently curved, similar in fact to forms already described in the other species of *Aphrocallistes* (Pl. LXXXVI. figs. 6, 11), and, on the other hand, regular or irregular discohexasters in which the terminal rays are also curved, and provided with rounded terminal knobs (Pl. LXXXVI. fig. 10). In addition to these, simple regular hexacts occur, in some specimens very abundantly. In these the rays are slender and tolerably long, smooth or rough, and always ending in fine points (Pl. LXXXVI. fig. 7).

The soft parts, which I was able to examine on some well-preserved spirit specimens, do not differ in disposition or minute structure from what has been already described in *Aphrocallistes bocagei*.

Family III. Coscinoporidæ, Zittel (Pls. LXXXVII.–XCI.).

The plate-like wall of the cup-, goblet-, or plate-shaped, firmly attached body is transversely penetrated by more or less elongated funnel-shaped straight canals, which open alternately on one or other surface (covered only by the sieve-like bounding skin), but are pointed and blend at the other end. Their length thus always corresponds to the thickness of the sponge body-wall.

Genus *Chonelasma*, n. gen. (Pls. LXXXVII.–XCI.).

The dictyonal framework of the beaker or almost plate-like specimens is traversed by two systems of oppositely directed funnel-shaped meshes or passages, which appear so arranged that each blind funnel extremity of the one system always occurs between the circumjacent funnel openings of the adjoining passages of the other and oppositely directed system. Those oppositely directed passages represent the incurrent and ex-

current canal spaces, and in every transverse section they may be observed to alternate with tolerable regularity.

The dermal skeleton consists of pentacts or hexacts with pronged terminal rays, and in addition to these numerous scopulæ of different forms occur.

The gastral skeleton consists of pentacts or hexacts, which exactly resemble the corresponding dermalia. It also contains in most cases scopulæ like those which are found in the outer skin.

In addition to the parenchymal uncinates, numerous discohexasters occur, more rarely oxyhexasters and sometimes also simple regular hexacts in variable numbers.

1. *Chonelasma lamella*, n. sp. (Pls. LXXXVII., LXXXVIII.).

In the neighbourhood of the Kermadec Islands (Station 170A, lat. 29° 45′ S., long. 178° 11′ W., 630 fathoms), the trawl brought up some fragments of a plate about the size of a little hand, from 5 to 10 mm. in thickness, and provided with attenuated, smooth, irregularly undulating margins. They are in some places somewhat bent and irregularly thickened, but on the whole they appear tolerably flat. The soft parts are well preserved. The two lateral surfaces exhibit to the naked eye no noteworthy differences. Both sides are covered by a fine delicate porous skin, through which are seen the round openings of the passages, which are about 1 mm. in width, and traverse the plate in alternately opposite directions. The distribution of these transverse canals is not, indeed, quite regular, yet the general arrangement of the rectangularly crossed longitudinal and transverse rows cannot be mistaken.

The two sides of the other macerated specimen are represented, from a photograph, in their natural size, on Pl. LXXXVII. figs. 1 and 2. They exhibit a slightly bent, but otherwise smooth macerated plate of 3·5 mm. in thickness, which was obtained at Station 148A (lat. 46° 53′ S., long. 51° 52′ E.), from a depth of 550 fathoms on hard ground, while the skeletal fragment figured on Pl. XC. figs. 9, 10, and 11, in natural size, which was dredged at Station 56 (lat. 32° 8′ 45″ N., long. 64° 59′ 35″ W.), from a depth of 1075 fathoms on Coral mud, appears to belong to the same species.

The macerated dictyonal framework exhibits notable variations in the different regions of the plate. While the beams in the neighbourhood of the two surfaces form a tolerably narrow-meshed, and somewhat irregular framework, which surrounds the wide round openings of the funnel-shaped transverse canals, the middle portion of the plate exhibits a regular system of perfectly square or rectangular meshes (Pl. LXXXVIII. fig. 1). Since these rectangular meshes in the middle layer are much wider than the meshes in the neighbourhood of the two bounding surfaces, and since the middle framework consists of beams, which are not only longer but thinner than those on the surfaces, it is easy to understand how this middle layer may readily break, and

then become spread over the entire plate in two lamellæ. The beams of the framework are more or less richly beset with pointed tubercles. The freely-projecting prongs or conical pegs are further especially rough and tubercled, while in the interior of the skeleton portions occur in which the beams appear almost or entirely smooth.

The dermal skeleton consists of strong pentacts of variable size, and in these the distal ray is entirely absent. The four cruciately disposed transverse rays are slightly and uniformly bent inwards, and each terminates in a blunt point. While the outer surface of these transverse rays is thickly beset with strong conical prickles, which gradually decrease in height towards the lateral margin, the inner surface is quite smooth (Pl. LXXXVIII. fig. 3). The simple conical attenuated proximal ray varies in length, and is, on the other hand, uniformly beset all round with a few simple conical prongs, which stand out at right angles.[1] In addition to the proximal radial ray of the pentacts, scopulæ extend towards the dermal membrane. These are to be reckoned among the smaller types. The stalk always ends in a somewhat rough point, and exhibits close beneath the forking an often sharply defined annular thickening. The four (more rarely three or five) teeth are quite distinct from one another, and somewhat divergent. They are either simply blunted or provided with an insignificant knob-like swelling.

The gastral skeleton lying on the other side of the flat section exhibits the same structure. Here also we find the same pentacts with a pronged upper surface, curved transverse rays, and a conical radial ray. The scopulæ are also similar to those of the dermal surface (Pl. LXXXVIII. fig. 1).[2]

Among the parenchymalia, in addition to the normal uncinates of variable length and thickness, numerous small discohexasters occur with somewhat rough straight rays, which may be slightly bent here and there, and bear terminally a small somewhat convex marginally fringed transverse disc. By division of one, or a few, or all of the rays into two or more (seldom more than four) terminal rays, discohexasters of various forms arise, in which the terminal rays are about three times as long as the shaft from which they spring (Pl. LXXXVIII. figs. 8, 9). Between these discohexacts and discohexasters, oxyhexacts and oxyhexasters of the same size, and on the whole of similar form, occur. They also exhibit a similar roughened surface.

The structure of the soft parts presents a general resemblance to that which we have already seen in the Euretidæ, except that, in relation to the much greater thickness of the wall, the afferent and efferent passages are longer and sometimes slightly ramified. From the subdermal lacunæ straight canals extend to near the subgastral spaces, and between these afferent passages lie the efferent canals, which are also straight, and extend from below the subdermal lacunæ to the subgastral cavities into which they open widely.

[1] In the figure (Pl. LXXXVIII. fig. 3) the prickles of the radial ray are by mistake provided with incurved, instead of perpendicularly disposed prongs.

[2] By mistake, the gastral scopulæ are omitted in the figure.

The efferent canals are surrounded by medium-sized, sharply defined thimble-like chambers, with their blind ends all turned towards the afferent canals and the subdermal space. They are, indeed, surrounded by the loose trabecular framework, which extends between them and the dermal membrane, and by the subdermal spaces, as well as by the afferent canals which traverse the framework without being always sharply defined from it. It is noteworthy that the chamber membrane is often so penetrated by the small parenchymal oxyhexasters that some rays of the latter project for a greater or less distance into the lumen of the chamber. On the outer wall of the chambers one frequently observes those groups of small cells which have been already several times discussed.

2. *Chonelasma hamatum*, n. sp. (Pl. XCI.).

In the locality in which the large plates of *Chonelasma lamella* were trawled (Station 170A, lat. 29° 45′ S., long. 178° 11′ W., in a depth of 630 fathoms, on volcanic mud), there was also found the smaller plate figured in its natural size on Pl. XCI. fig. 1. This is bounded by an irregularly undulating surface, and is only about 3 mm. in thickness, while it is provided with a thin rounded margin. Apart from some slight curvatures this plate also in general forms a flat expansion, and appears to have been firmly attached by the narrow extremity.

The structure of the tolerably regular dictyonal framework agrees essentially with that of *Chonelasma lamella*. The meshes are, however, narrower and are not markedly wider in the middle layer of the plate than near the surfaces. The tuberculation on the surface of the tolerably strong network of beams is not uniform throughout. In some parts it is very pronounced, in others it is almost entirely absent, with the exception of the projecting pegs. Small tubercled hexacts occur very regularly and are transversely or obliquely soldered to the regularly formed framework of beams.

The alternating funnel-shaped canals, which traverse the plate, opening on the one side and terminating blindly on the other, have a maximum width of 0·5 mm.

The dermal skeleton consists of hexacts, each of which has a short distal ray, provided with a slightly knob-shaped thickening and densely beset with tubercles, while their four cruciate, long, straight, transverse rays and the still larger proximal ray are smooth at the base, but rough at the pointed extremities (Pl. XCI. figs. 2, 5). In addition to these dermal hexacts, scopulæ of various forms occur, in which the stalk is provided with a rough pointed or rounded internal terminal portion, while the expanded outer extremity exhibits, close beneath the teeth, an annular thickening or four cruciately disposed archings, or else gradually passes into the bases of the teeth. I have never been able to determine more clearly than in this thickening beneath the teeth an intersection of the principal canal by two short transverse canals disposed at right angles to it. These transverse canals do not, however, pass into the teeth, but remain straight and

terminate in the circular swelling or in one of the four tubercles, while the prolongation of the principal canal is likewise straight, and terminates close beneath the teeth. Hence I am of opinion that I can with certainty exclude the view that the teeth are to be regarded as curved principal rays, and maintain the opinion that they are terminal rays of a greatly shortened radial principal. These terminal rays are as a rule rough and straight, and provided with terminal knobs. There are usually four, but three may also occur. Exceptionally an S-shaped curvature occurs, as on Pl. XCI. fig. 4.

The gastralia are so essentially similar in form and position to the dermalia that no special description is required. I may simply refer to Pl. XCI. fig. 2.

In the parenchyma tolerably regular uncinates of various dimensions occur in great numbers, but extend usually only through half the thickness of the plate. They are all disposed at right angles to the surface. In the uncinates occurring near the dermal surface all the barbs have their points towards the gastral side, while in the uncinates which lie closer to the gastral side, the points of the barbs are turned round and directed towards the dermal surface. On both surfaces therefore the uncinates would on gentle motion project outwards from the sponge body. The numerous small hexacts, which are for the most part fused to the dictyonal framework, but partly also occur free in the soft tissue, are provided with pointed tubercles, and each of the rays is obliquely pointed at the extremity. Moreover many elegant discohexasters also occur in the parenchyma, and exhibit various forms. Very frequently small rosettes, such as are figured on Pl. XCI. fig. 6, occur, and each of the moderately short basal rays bears four, five, or six terminals, which are curved in an S-like manner like petals, and knobbed or provided with terminal discs. More rarely forms occur in which the basal rays are somewhat longer and more slender, and are united in a spherical central knot. These bear on their outer extremities from three to four very fine long terminal rays with terminal discs. Whether the rosettes with long rough basal rays, which are represented on Pl. XCI. fig. 7, and which I found here and there in preparations of *Chonelasma hamatum* really belong to this species and are not merely intrusions, I have lately seen reason to doubt. In any case, however, should they really belong to this sponge, they are of very rare occurrence.

The structure of the soft parts differs from that described in *Chonelasma lamella* at most in the greater simplicity of the straight afferent and efferent canals which traverse the plate at right angles (Pl. XCI. fig. 2).

3. *Chonelasma dœderleinii*, n. sp. (Pl. XC. figs. 1–7).

Among the Hexactinellida which were collected by Dr. Döderlein in the Sagami Bay (Japan) there are some irregularly bent plates from 2 to 3 mm. in thickness which are preserved in the dry state. These are provided with a thin undulating margin, are from 2 to 3 cm. in breadth, from 4 to 5 cm. in height, and without doubt were attached to a solid

substratum by means of the narrow inferior surface. There is also a fragment of similar structure preserved in spirit, and this has been especially serviceable for microscopic examination. Although the macroscopic and microscopic structure of this fragment essentially agree with those of *Chonelasma hamatum*, there are several points of difference, especially in regard to the form of the isolated spicules, and these differences appear to me to be sufficient for the erection of a distinct species. I have named this species in honour of Dr. Döderlein who gave it over to me for examination.

In the dictyonal framework the two funnel-shaped systems of canals, which open alternately on the two lateral surfaces, are narrower than in *Chonelasma hamatum*, but this might be associated with the slight thickness of the entire plate. The beams of the network exhibit the more or less tubercled surfaces noted in the above species. There is further great regularity in the square or rectangular meshes of the middle layer, while the meshes near the two surfaces appear more irregular and rounded.

The strands of beams which run parallel to both sides, and cross each other approximately at right angles, are for the most part perpendicular and parallel to the upper boundary. When this therefore is somewhat curved, as in the specimen represented in Pl. XC. fig. 1, a more circular and radial disposition of the beam-strands results.

The hexacts of the dermal and gastral skeleton are provided with a short, broad, almost oval, brush or fir-tree-like freely projecting ray, while the four moderately long transverse rays and the strong conical proximal radial (which varies in length and penetrates into the parenchyma), are smooth at their base and rough towards the extremities (Pl. XC. figs. 2, 3). The scopulæ which occur both in the dermal and gastral skeleton all have a shaft which runs out to a fine point, but vary greatly in the form of the teeth and of that expanded portion of the shaft which bears them. The latter sometimes exhibits a simple thickening, or in some cases an annular swelling or four cruciately disposed knobs, and into these the short transverse rudiment of the axial canal extends.

The teeth are almost always in fours and appear either as rods thickly beset with barbs provided with slender terminal knobs, and running almost parallel to one another; or while remaining similar in form they may diverge slightly outwards (Pl. XC. fig. 6); or they are slender and show a tendency to become somewhat curved in an S-like manner (Pl. XC fig. 5).

In addition to the uncinates of variable strength which I have found only in the middle and dermal portions of the parenchyma, the latter contains discohexasters of variable strength, and these bear on the extremity of every short basal ray three or four long, thin, diverging, somewhat curved terminal rays with pronged terminal discs (Pl. XC. fig. 7). Sometimes the number of terminal rays on one or other principal ray is reduced, and I even observed some discohexasters with irregular undulating rays.

The structure of the soft parts does not exhibit any essential deviation from that already described in *Chonelasma lamella* and *Chonelasma hamatum* (Pl. XC. fig. 2).

4. *Chonelasma calyx*, n. sp. (Pl. LXXXIX.).

In contrast to the above described simple plate-like forms, the species now to be noted, which I have established from three dried and partly macerated specimens obtained by Dr. Döderlein in Enoshima, has the form of a cup several decimeters high, with nipple or glove-finger-like radial protuberances from the wall, which is 5 mm. in thickness. The majority of these parietal protuberances, which have the thickness of one's finger or thumb, exhibit a terminal or subterminal circular aperture from 3 to 5 mm. in diameter, and are continued as thinner tubular or half channeled hollow irregular cylindrical processes, which either extend obliquely downwards and reach the firm substratum, or unite with the adjoining processes of neighbouring diverticula (Pl. LXXXIX. figs. 1, 2). The whole wall is traversed by canals which open alternately on the inner and outer side, but the dried specimens at my disposal do not show the arrangement with equal clearness throughout.

The dictyonal framework, which consists partly of perfectly smooth beams and partly of beams sparsely covered with tubercles, exhibits a thicker and less regular meshwork in the neighbourhood of the outer and inner bounding surfaces than in the middle layer, where the meshes are large and more uniformly rectangular. The dermal skeleton consists of hexacts, each of which has a terminally corroded, knobbed, and fir-cone-like distal ray which is beset with pointed prongs, while the long conical proximal ray, and the four moderately long transversals, are either quite smooth or beset on their outer extremities with small tubercles. In addition to the hexacts, the very numerous radially projecting scopulæ usually bear six, more rarely five or four, barbed, more or less markedly diverging, knobbed terminal rays, or a cap-like swelling on the shaft which terminates in a rough point (Pl. LXXXIX. fig. 6). The spicules of the gastral skeleton exhibit a similar structure, but the freely projecting (proximal) ray of the hexacts is often somewhat more slender than in the dermal hexacts. The scopulæ, moreover, vary considerably in the number of their barbed and usually markedly knobbed terminal rays.

The parenchymal uncinates are remarkable for their strength. The greatest swelling always occurs in the anterior third dermal portion. Among the smaller loose parenchymalia numerous discohexasters and oxyhexasters must be noted. The number of the moderately long terminal rays varies, as has already been described and figured in *Chonelasma lamella*. The same small discohexacts appear as in the above.

Chonelasma sp. (Pl. XC. figs. 8-11).

Besides the largest specimens figured in Pl. LXXXVII. figs. 1 and 2, fragments of macerated dictyonal framework belonging to a *Chonelasma* form were found at various stations on the Challenger Expedition. I have not been able to refer these with any

certainty to one or other of the above described forms, nor are the characteristics sufficiently distinctive to permit of the erection of a definite species. In some of the fragments, however, several features are very distinctly developed, to some of which it seems worth to refer. In Pl. XC. figs. 9, 10, and 11, I have given figures from photographs of a plate-like specimen dredged near the Bermuda Islands (Station 56, lat. 32° 8′ 45″ N., long. 64° 59′ 35″ W.), from a depth of 1075 fathoms and a coral mud ground. One surface, probably the dermal, has unfortunately been very much rubbed (fig. 11), so that on surface view only the deeper layers of the framework are to be seen. The surface represented in fig. 10 seems to me to be gastral, so that the very regularly formed layer of the framework, displayed with its distinctly rectangular meshes in fig. 11, lies close beneath the gastral surface. A section at right angles through the best preserved portion of the plate (fig. 9), displays very distinctly the alternation of the straight funnel-shaped spaces of the afferent and efferent canals.

Among numerous small macerated fragments dredged near the Penguin Islands (Station 148A, lat. 46° 53′ S., long. 51° 52′ W.), from a depth of 550 fathoms and a bottom of hard ground, gravel, and shells, besides the larger plates represented in Pl. LXXXVII. figs. 1 and 2, there was another which exhibited a very characteristic thickness. In the cross section (Pl. XC. fig. 8), as in the above instance (Pl. XC. fig. 9), the alternation of funnel-shaped canal spaces can be detected. I am inclined to believe that the *Scleroplegma herculeum* (from Santa Cruz), referred to by Oscar Schmidt in his Spongien des Meerbusens von Mexico (p. 57), is a similar form.

In the neighbourhood of St. Thomas (Station 23B, lat. 18° 28′ N., long. 63° 35′ W.), from a depth of 590 fathoms, and a Pteropod ooze bottom, other small *Chonelasma* fragments were obtained, as also on the coast of Portugal at localities not recorded.

Family IV. TRETODICTYIDÆ, F. E. Schulze (Pls. XCII.–XCVIII.).

With irregularly arranged afferent and efferent canals, which penetrate the body-wall, and especially the more or less thick dictyonal framework, not transversely but obliquely, or in a longitudinal direction, or even in a coiled course.

Genus 1. *Hexactinella*, Carter (Pls. XCIII.–XCVI.).

1885. H. T. Carter, Ann. and Mag. Nat. Hist., ser. 5, vol. xv. p. 387.

History.—After I had completed my investigation of the Challenger Hexactinellida, and had given names to the new forms which I had determined, I discovered that the form designated by Carter *Hexactinella ventilabrum*[1] was identical with the species to which

[1] *Ann. and Mag. Nat. Hist.*, ser. 5. vol. xv. p. 387, 1885.

I had given the title *Tretodictyum cyathus*. I do not hesitate, therefore, to abandon my generic and specific designation for this form, and to adopt Carter's title, which has the priority. Thus the generic title *Tretodictyum* is wholly given up, and the two other species which belong to the same genus are no longer called *Tretodictyum tubulosum* and *Tretodictyum latum*, but *Hexactinella tubulosa* and *Hexactinella lata*.

The specimen figured by Carter, unfortunately not in its entirety, was obtained from Misaki, Japan, at the extrance of the Bay of Tokio. According to his description, it closely resembles the *Phakellia ventilabrum*, Bwk., figured by Bowerbank in his Monograph of British Sponges.[1] "The surface is on both sides even and uniform; uniformly scattered over internally with circular apertures about $\frac{1}{12}$ inch in diameter, and about the same distance apart, and externally with a dermal, quadrilateral, spicular reticulation." "Wall about $\frac{1}{6}$ of an inch thick, composed of two layers, viz., one on each side of an irregular central plane of condensed tissue, each layer consisting of plumose fibre curving upwards and outwards florally from the central plane of condensed tissue, strengthened by transverse fibres in their course."

Isolated spicules are represented, according to Carter, by the following types :—(1) dermal pentacts; (2) uncinates, called barbulæ by Carter; (3) thin oxydiacts; (4) scopulæ with two, three, or four slightly divergent teeth; (5) simple or spinose oxyhexacts; (6) oxyhexasters and discohexasters of different kinds.

Character of the Genus.—The wall of each of the cup-shaped or tubular specimens is traversed by canals, which are not exclusively disposed at right angles to the bounding surface.

The dictyonal framework is principally composed of radial, longitudinal, straight or slightly bent fibrous reticulate plates, about 1·5 mm. in breadth. These are separated from one another by spaces of similar form and breadth, but are at the same time bound together laterally by numerous transverse beams. A more irregularly developed fibrous network with round openings extends in some species over the outer, in others over the inner (gastral) surface of the dictyonal framework, and thus conceals either on the outside or inside the above mentioned longitudinally directed radial plates and their cleft-like interspaces.

The dermal and gastral skeleton consists of pentacts or hexacts, and numerous scopulæ of various forms. In addition to delicate uncinates, numerous oxyhexasters, discohexasters, and more rarely small oxyhexacts and discohexacts appear in the parenchyma.

1. *Hexactinella tubulosa*, n. sp. (Pl. XCIII.).

Simple or dichotomously branched, sometimes also laterally anastomosing tubes about 1 cm. in diameter, with a wall varying from 2 to 3 mm. in thickness, rise from a flat

[1] Vol. iii. pl. xxii.

base, which may either have grown upon a solid body, or may have formed a flat expansion on somewhat loose clayey ground.

The largest of the specimens, bought by Dr. Döderlein in Enoshima in a dried condition, attains a height of 10 cm. On the outer extremity of the tubes a simple smooth-margined oscular opening occurs. Through the dermal and gastral sieve-like skin the canals, which are from 1 to 2 mm. in width, may be recognised.

In the dictyonal framework, which has been isolated by maceration, the gastral margins of the longitudinally disposed dictyonal plates project freely on the inner surface, while an irregular network of beams with round openings from 1 to 2 mm. in diameter extends over the exterior.

The dermal skeleton is formed of strong pentacts, with numerous inequalities over the entire surface. A round knob or peg represents the atrophied distal (sixth) ray. The long proximal ray and the four tangentials generally terminate in sharp points. Scopulæ also occur, each provided with a moderately long, terminally rough and pointed stalk, and bearing on the outer simple conical expanded extremity of the latter four rough, slightly capitate or entirely unknobbed, parallel or slightly diverging, terminal rays (Pl. XCIII. fig. 4). In some specimens numerous fine spicules, which run out to a point at both ends, occur in groups close to the proximal ray of the pentacts, and project somewhat above the skin.

In the gastral skeleton, curiously enough, I have found no pentacts or hexacts, although numerous scopulæ similar to the dermal forms were present in the familiar radial position (Pl. XCIII. figs. 2, 5).

The loose parenchymalia consist of very thin and short uncinates (Pl. XCIII. fig. 3) of simple, slender, or somewhat rough hexacts (Pl. XCIII.) and oxyhexasters, each of which bears two diverging, short, and strong straight terminal rays on each of the moderately long basal principals.

2. *Hexactinella lata*, n. sp. (Pls. XCIV., XCV.).

Dichotomously branched tubes, which tend to anastomose, varying from 1 to 4 cm. in diameter, expanding superiorly in funnel-like form. They are also frequently crowded together laterally, and appear to be pitted or swollen out here and there in an irregular manner. The wall of the tube has a thickness of 2 to 2·5 mm. Through it one can clearly recognise the radial and also the generally longitudinal, frequently undulating or meandering plates, with the intervening spaces, while on the inner surface only irregular round spaces are to be observed through the gastral skin (Pl. XCIV. fig. 1). In completely macerated specimens it may be seen that, in the parallel longitudinal radial plates of the dictyonal framework, the longitudinal fibrous bands exhibit an external

curvature towards the dermal surface. The lateral union of these longitudinal radial plates, which are separated by spaces of uniform breadth, is effected by means of transverse bridges of the same dictyonal framework. These extend uniformly on the gastral side, where they are perforated only here and there by long oval openings, while similar bridges arching over the interradial spaces on the dermal side have a more limited longitudinal extension. In this manner a canal system is formed, which is, for the most part, longitudinally disposed, and is here and there dichotomously branched. It opens towards the outside by somewhat long longitudinal clefts, towards the inside by round or oval pores; and since the inner openings are frequently arched over by the external connecting bridges of the adjoining radial plates, it often results that a transverse section of a complete tube exhibits the appearance of a folded plate (Pl. XCIV. fig. 3; Pl. XCV. fig. 1). The beams of the fibrous framework bear small superficial knobs, which are either irregularly scattered or arranged in incomplete transverse rows (Pl. XCV. fig. 2). The nodes of intersection are somewhat thickened and knobbed here and there, especially in the outer layer of the framework.

On the outer (dermal) surface the dermal membrane extends quite uninterruptedly over all the clefts and openings, while on the inner surface the gastral membrane passes into the excurrent openings of the larger efferent canals, which in most cases traverse the wall very obliquely.

The strong dermal pentacts almost invariably exhibit a button-, peg-, or knob-like rudiment of a sixth distal ray. The proximal ray, which varies in length, and the four tolerably long, and in most cases slightly curved tangential rays, terminate in points and are beset with small conical knobs all over in the case of the larger spicules, but only on the extremities of the rays in the smaller (younger) forms. Strong scopulæ[1] also occur, in which the four parallel or slightly diverging, thick or slender, rough knobbed terminal rays usually arise just above an annular quadri-tuberculate thickening of the stalk (Pl. XCIV. fig. 8).

Finely pointed slim oxydiacts extend here and there in bundles, close to the proximal ray of many dermal pentacts, in the dermal membrane, and even above the latter.

The gastral skeleton almost completely resembles the dermal. A distinction could only be found in the fact that the pentacts are less strong, and their projecting rudiment of the sixth ray is somewhat longer, so as almost to warrant the term hexact. The gastral scopulæ agree completely with the dermal.

The parenchyma contains delicate uncinates, and numerous isolated, thin-pointed spicules, which are united in somewhat loose bundles. Besides small hexacts of various dimensions and provided with small terminal knobs (Pl. XCV. figs. 3, 4), sphærohexasters occur. These have a variable number of curved terminal rays, which are in most cases only of medium size, and are convex externally (Pl. XCIV. figs. 6, 7,

[1] The scopulæ figured on Pl. XCIV. figs. 5, 9, do not belong to this form. They are casual intruders.

13). Oxyhexasters, with long pointed terminal rays, rarely occur[1] (Pl. XCIV. fig. 10). The structure of the soft parts does not essentially differ from that observed in the Euretidæ. The few specimens of this form were trawled near the Little Ki island (Station 192, lat. 5° 49′ 15″ S., long 132° 14′ 15″ E.), from a depth of 140 fathoms, and a blue mud ground.

3. *Hexactinella ventilabrum*, Carter (Pl. XCVI.).

The elegant simple cup represented on Pl. XCVI. figs. 1, 2 (measuring 8 cm. in height and 12·5 in greatest breadth), belongs to the collection of Hexactinellida which was made by Dr. Döderlein in Enoshima, Japan. From a base about the size of a half-crown, a strong, laterally-compressed stalk, 3 cm. in breadth and 1 cm. in thickness arises, and this is continued into the somewhat bent body, which is compressed in the same direction. This somewhat resembles a boat, and its cavity exhibits the openings of a row of twelve branching canals of approximately equal width. The circular openings measure from 2 to 4 mm. in diameter (Pl. XCVI. fig. 2).

Since the dermal and gastral skin in this dried specimen are only preserved here and there in small remnants, the coarser structure of the dictyonal framework can be recognised without further trouble. As in *Hexactinella lata*, the free outer margins of the radially and longitudinally disposed, reticulate, fibrous plates (1 mm. in breadth), distinctly project on the external dermal surface, while on the gastral surface of the cup they are covered by the evenly expanded fibrous network. Instead, therefore, of clefts 1 mm. in breadth, only round pores of equal breadth occur on the inner surface. The meshes of the dictyonal network of fibres appear in many places to be almost regularly square, although the longitudinal fibrous strands frequently run not quite parallel to the bounding surface, but in arched bundles from the middle layer of the wall, and diverge slightly towards the free outer and inner surfaces, so that their extremities project freely on the surfaces. The beams of the fibrous network are irregularly, and more or less abundantly beset with low knobs. The dermal skeleton includes strong pentacts like those in the skin of *Hexactinella tubulosa* and *Hexactinella lata*, also strong, four-toothed scopulæ, and numerous fine spicules which are pointed at both ends. Constituent elements of exactly the same character are to be found in the gastral skeleton.

The parenchyma contains minute, rough rods, with pointed extremities, which correspond somewhat to the uncinates. There are also oxyhexasters, with tolerably long, diverging, terminal rays (Pl. XCVI. fig. 8), further, discohexasters with long basal principals, and numerous short (externally slightly convex) terminal rays (Pl. XCVI. fig. 5), and finally, discohexasters with short basal principals, and a few (three to five) straight or S-shaped, tolerably long terminal rays (Pl. XCVI. fig. 4).

[1] The spicules figured on Pl. XCIV. figs. 11, 12, seem to have come in accidentally, and were not found on careful re-examination.

Genus 3. *Cyrtaulon*, F. E. Schulze (Pl. XCII.).

Volvulina,[1] O. Schmidt.

1880. O. Schmidt, Spongien des Meerbusens von Mexico, p. 58.

History.—Among the sponges of the Gulf of Mexico, Oscar Schmidt[2] found some Hexactinellida of cylindrical, globular, or beaker-like form, which were procured from Morrolight, Barbados, and St. Vincent, from a depth varying from 100 to 300 fathoms. These he has embraced under the specific name of *Volvulina sigsbeei*. Their siliceous networks are united in an irregular lattice-work by strands, varying from $\frac{1}{3}$ to 3 mm. in thickness. Between these strands there are pores and passages, the outer openings of which appear to be covered by a membrane. A true gastral cavity was not observed, but, on the other hand, a pitting here and there was regarded as *pseudogastral*.

The dictyonal framework exhibits knobbed and also smooth beams. These unite in some species in round tubercled nodes of intersection, while thickenings of this kind are entirely absent at the intersections in other species.

In the outer skin hexacts or pentacts occur, and these are arranged in a regular network. Moreover, among free spicules there are (1) slender thorny spicules (uncinates), which, in the specimens procured from St. Vincent, always exhibited a central circular swelling; (2) club-shaped brooms (scopulæ); (3) hexacts with large finely-toothed hooks on the ends of the rays; (4) umbel-like rosettes (discohexasters), the single ray in each of which is prolonged without forking, and terminates in a point, but with a little thickening before the extremity.

In the fragment figured in Pl. XCII. fig. 9, which was very kindly intrusted to me by Professor Oscar Schmidt for comparative examination, I was able to corroborate his important remarks on the striking want of uniformity in the dictyonal framework. I find on the outer surface greatly thickened beams, which are richly beset with large wart-like knobs; in the interior of the framework the beams in some places are ornamented merely with small pointed knobs, while in others, on the contrary, they are quite smooth. While in some species densely tuberculate nodes of intersection are present, these are completely absent in others.

I have indicated above the general characters which may be inferred from the specific features noted by Oscar Schmidt, but the generic diagnosis of *Volvulina*, in contrast to that of some allied genera, may be formulated in the following manner :—

Cyrtaulon, F. E. Schulze (= *Volvulina*, O. Schmidt).

Cylindrical, conical, or beaker-shaped forms, in which the dictyonal framework con-

[1] The name "*Volvulina*" has been applied to a Gasteropod since 1865.
[2] O. Schmidt, Spongien des Meerbusens von Mexico, p. 58, 1880.

sists of irregularly united fibres, reticulated beams, with interposed irregular spaces and passages, the outer orifices of which are covered by a dermal membrane. In addition to the regularly disposed dermal pentacts or hexacts there are scopulæ with knobbed branches. The parenchyma contains, besides uncinates, scopula-like spicules, each of which is provided with one prolonged principal ray, which runs out to a fine point.

1. *Cyrtaulon sigsbeei*, O. Schmidt (Pl. XCII. fig. 9).

Since I am inclined to believe that the description which O. Schmidt (*loc. cit.*, pp. 58, 59) has given of his *Volvulina sigsbeei* was based on specimens of different species, I must, in regard to the minute structure, restrict myself in the first instance to that specimen of which only a fragment is available, as represented from a photograph in Pl. XCII. fig. 9. For an account of the more macroscopic characters I must simply refer to O. Schmidt's results.

We have here to deal with very variously shaped, often goblet-like specimens, whose wall consists of an irregular feltwork, with anastomosing cavities both on the external and on the internal bounding surface, covered over by a porous skin.

The dictyonal framework consists of tuberculate beams, in which the nodes of intersection are here and there, and especially near the surface of the body, thickened and beset with wart-like elevations.

The parenchyma contains uncinates with central thickened nodes, and scopula-like spicules with several thin prongs radiating out from the terminal knob of the stalk, and bearing marginally-toothed terminal discs. The dermal skeleton consists of pentacts and hexacts, and also of scopulæ with knobbed prongs.

As to localities, O. Schmidt mentions (1) Barbados, 100 fathoms; (2) lat. 32° 9′ N., long. 82° 23′ W., 158 fathoms; (3) Morrolight, 292 fathoms; (4) St. Vincent, 124 fathoms.

2. *Cyrtaulon solutus*, n. sp. (Pl. XCII. figs. 1-8).

Among the numerous Hexactinellida which were obtained by the Challenger at Station 192 (lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.), near Little Ki Island, from a depth of 140 fathoms, on blue mud ground, there is one dried specimen which grew in the tubular cavity of a piece of limestone, and which had the form of a cylinder 5 cm. in length and 2 cm. in breadth. As may be observed in the sketch given on Pl. XCII. fig. 1, the dictyonal framework passing through the body consists of irregularly united flat or rounded beams from 1 to 2 mm. in thickness, which surround interspaces and passages from 3 to 4 mm. in breadth. As may be clearly recognised in some parts of the surface which have been specially well protected by the surrounding stone, the whole was covered by a cylindrical mantle-like veil, which exhibits in the dried state a square-meshed network with large

and small spaces, and extended continuously over the spaces and openings. No wide gastral cavity or oscular opening is to be recognised.

The microscopic examination of the dictyonal framework reveals a somewhat irregular network of beams which are beset with moderately large smooth tubercles of irregular number and arrangement. The beams never exhibit a spherical thickening of the nodes of intersection. In dead portions the axial canals of the dictyonal hexacts are here and there greatly enlarged, and accordingly well marked. The dermal skeleton consists chiefly of moderately large, smooth, or only terminally somewhat tubercled pentacts, which form by their apposition a beautiful square meshed lattice-work. In addition to this, bundles of fine spicules pointed at both ends jut out, and scopulæ of different forms occur, but especially forms provided with rough pointed shafts and four strong, almost or absolutely parallel teeth, densely beset with barbs. These teeth spring from a simple conical expansion of the shaft, and possess no knob-like terminal swellings (Pl. XCII. fig. 5).

On the surface of the large inner strands and plates of the dictyonal fibrous framework there are no pentacts, but only scopulæ, and unpointed fine spicules which also appear to constitute the skeleton of the gastral membrane.

In the parenchyma, and between the reticulated beams of the dictyonal framework, there are uncinates, which usually exhibit a slight curvature, and further, those spicules which are characteristic of the genus *Cyrtaulon* and were first described by Oscar Schmidt, who regarded them as discohexasters with a greatly prolonged ray. These forms exhibit a simple shaft, which runs out to a fine point, and is provided on the pointed terminal portion with rough knobs; on the other extremity with a knob- or ball-like thickening, which bears a somewhat large number of thin terminal rays with terminal discs. The thickening which occurs close beneath the pointed extremity of the arrow-like shaft in *Cyrtaulon* (*Volvulina*) *sigsbeei* is here entirely wanting. This peculiar form of spicule may be best regarded as a modification of a hexaster, but I have not found any indications of the basal parts of principal rays, except the long shaft. All the thin terminal rays originate directly from the knobbed terminal thickening of that shaft. In addition to the scopulæ with four thick rough teeth, already mentioned in the dermal skeleton, other forms with four thin smooth teeth and simple terminal knobs apparently occur in the parenchyma, in addition to those which bear six thin smooth similar terminal rays with terminal knobs or discs (Pl. XCII. fig. 6). If one imagines the number of these teeth to be increased and their position more irregularly radial, one can also understand the unusual form of parenchymalia. I have not found any regular hexacts in *Cyrtaulon solutus*.

Genus 4. *Fieldingia*, Sav. Kent (Pl. XCVII.).

1870. Saville Kent, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 219.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii. p. 124.

History.—On a specimen of *Lophohelia prolifera*, var. *anthophyllites*, which was dredged ten miles off the shore of Cezimbra, Portugal, from a depth of 500 fathoms, Saville Kent found[1] in 1870 a Hexactinellid, distinguished by a pustulate rind of fine recticulated laminæ and numerous spherical internal bodies, varying in diameter from $\frac{1}{30}$ to $\frac{1}{15}$ of an inch. He named it *Fieldingia* in honour of Mr. Edward Fielding, adding the specific name of *lagettoides,* in reference to the delicate reticulate laminæ associated with the cortex, which are so strongly suggestive of the internal lace-like layers in the bark of the lace-bark tree. His brief diagnosis of the new form was :—"Sponge adherent, consisting of a cortex of irregular reticulated spicula, having on its interior surface numerous reticulated laminæ of extremely delicate consistence. Common cavity of the sponge containing numerous spherical aggregations of spicular reticulations ; these invested and brought into relation with the cortex by loose reticulated fibres of coarser structure, having a general hexradiate arrangement ; these fibres cylindrical, and to a considerable extent minutely and erectly spined ; frequently attached to them very diminutive spicula of the 'rectangulated hexradiate' type, these also minutely and erectly spined. Nutritive and exhalent functions most probably performed through the general reticulations of the cortex."

Marshall, who in 1876 ranked[2] *Fieldingia* along with *Aphrocallistes* as "aberrant forms" among his Pleionacidæ, suggested that the form was probably a young *Aphrocallistes.*

Fieldingia lagettoides, Sav. Kent (Pl. XCVII.).

The drawing on Pl. XCVII. fig. 1 represents in its natural size one of the two dried specimens which were trawled by the Challenger off Little Ki Island (Station 192, lat. 5° 49′ 15″ S., long 132° 14′ 15″ E.), in 140 fathoms, on blue mud ground. The surface of the knob-like specimens, which are as large as a walnut, consists in the perfectly intact regions of a strong external rind, associated with adherent granules of sand and other foreign bodies. The rind appears here and there somewhat blistered and almost spongy, and consists of several lamellæ of a very narrow meshed and irregular network. An irregular framework of strong siliceous beams with partly square meshes (from 1 to 3 mm. in width) extends from the rind across the lumen. This framework of beams exhibits numerous thick spherical knots about 1 mm. in diameter, and with tolerably

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. vi. p. 219.
[2] *Zeitschr. f. wiss. Zool.*, Bd. xxvii. p. 124.

uniform distribution. These occur at intervals of 2 to 3 mm., and are not otherwise remarkable, except as local condensations of the network of beams. Both on the beams of the wide meshed part of the framework, and on the outer surface of the knots, small simple hexacts occur fused together in variable numbers. All the beams of the framework and the small fused hexacts are more or less richly beset with small tubercles.

From what has been said there can be no doubt that the specimens in question belong to the species *Fieldingia lagettoides*, Sav. Kent, which Saville Kent found on a specimen of *Lophohelia* at Cezimbra, Portugal, and which he has figured and described. But it is to be regretted that in many parts of the present specimens the remarkable blistered rind, which is of several layers, is insufficiently preserved for accurate examination. From the fragments, however, it may be seen that we have to deal with lattice-like lamellæ, which exhibit the crossed tangential rays of numerous pentacts, in which the fifth ray projects inwards. Between these pentact rays, which are remarkable for their distinct axial canals, there extends a more or less well-developed, in part very narrow-meshed, network of connecting beams without central canals, and provided with rounded meshes. This is similar to what is found in the basal plate of many fixed Hexactinellida, and in the regions of contact between these and solid foreign bodies. Since the free outer surface is covered with sand and other extrinsic elements, the supposition is confirmed that we have here to deal with a dermal skeleton altered by an admixture of foreign bodies.

Among isolated spicules several apparently typical forms occur. It is not possible to determine with certainty their normal arrangement or stratification. In addition to various strong uncinates (Pl. XCVII. fig. 9), simple straight smooth diacts frequently occur. These exhibit a central swelling or four cruciately disposed knobs, and their two extremities form a point which arises by a process of pitting (Pl. XCVII fig. 8). In addition to simple smooth and delicate hexacts (Pl. XCVII. fig. 7), oxyhexasters occur, which have several or all of their rays forked. The principal ray usually remains very short (Pl. XCVII. fig. 6), and sometimes, indeed, it is so much abbreviated that the terminal rays appear to rise almost directly from the node of intersection, and in this way a simple star with ten or more rays results (Pl. XCVII. fig. 3). Discohexasters with two or more fine long terminals on each of the short principal rays, and with marginally toothed somewhat convex terminal discs, are tolerably frequent (Pl. XCVII. fig. 4).

The scopulæ, which probably belong to the dermal skeleton, exhibit four strong almost parallel teeth, which are beset with barbs, and are slightly knobbed, or terminate without any swelling. The teeth spring from the conically thickened extremity of the rough and pointed shaft. Less frequently the teeth diverge in the manner represented on Pl. XCVII. fig. 5.

Genus 5. *Sclerothamnus*, Marshall (Pl. XCVIII.).

1875. Marshall, Zeitschr. f. wiss. Zool., Bd. xxv., Suppl., p. 171.
1876. J. Murie, Trans. Linn. Soc. Lond. (Zool.), ser. 2, vol. i.
1876. Carter, *Ibid.*, Appendix.

History.—The term *Sclerothamnus clausii* was applied by Marshall [1] to a bushy-branched Hexactinellid obtained from an unknown source. It measured 50 cm. in height, while the cylindrical branches, which were repeatedly forked, had a diameter of 3·5 cm. towards the extremities, and of 13 cm. at the basal ends. In the tolerably uniform framework of siliceous beams, which consists of fused hexradiate spicules with tubercled external surfaces, Marshall thought he perceived a continuous connection between the axial canals, which exactly met one another in the fusion of adjacent hexradiate spicules, and thus remained in open communication. The broad (5 mm. in diameter) and narrow (1 mm. in diameter) canals, which traverse the branches of the sponge, often anastomose with each other, and open outwards by orifices of variable size. Many of these excurrent passages, moreover, possess a fringe in the form of a freely projecting cuff, but on the whole the canal system seems to be indistinctly and irregularly developed in the dense tissue.

Among free spicules Marshall found (1) large-knobbed hexradiate forms, which fuse to form the continuous framework ; (2) very small fine regular hexradiate spicules ; (3) broom-forks with five clubs, beset with delicate warts on each of the expanded portions, while their stalk, which is covered with similar warts down to a slight swelling, terminates in a short point ; (4) longer broom-forks (Besengabeln) with four long clubs, in which the stalk, like the spicular shaft, is beset with fine recurved hooklets.

In the following year, 1876, there appeared in the Transactions of the Linnæan Society (Zoology), ser. 2, vol. i., a detailed paper illustrated by numerous good figures, On Steere's Sponge, a New Genus of the Hexactinellid Group of the Spongidæ, by James Murie. This bushy branched Hexactinellid was procured by natives from a depth varying from 80 to 100 fathoms in the neighbourhood of the Philippines, " between the strip-like and parallel islands of Negros and Cebu." In its dried state it measured about 80 cm. in height, and exhibited branches as thick as one's finger. The form is accurately described under the name of *Dendrospongia steerei.* Professor Steere had bought this beautiful specimen during his stay in the Philippines from fishermen " on the opposite eastern side of the island of Cebu, where no sponges are said hitherto to have been got from the sound or channel above-mentioned." Murie reports [2]—" One day, while in the forest, Professor Steere was suddenly apprised of the arrival of the Challenger Expedition by a note from Professor Wyville Thomson, who had heard of him and his whereabouts. He hastened on board, passing, as he assures me, a most agreeable day in the

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxv., Suppl., p. 171, 1875.
[2] *Loc. cit.*, p. 221.

company of our countrymen. He doubts if the English naturalists obtained any other specimen of this sponge (*Dendrospongia*), though he told them of his one, and where and how acquired." In a note Murie made the following addition :—" Since reading this communication, Sir Wyville Thomson's return has enabled me to show him the accompanying plates; the species he does not recognise as being among their collections, although it is possible a less perfect specimen or fragmentary portions may be found among the stores of material as yet imperfectly worked out."

According to Murie's description and figures, "The general surface exhibits several broad but very shallow impressions or concavities which traverse the stem obliquely. The distinguishing feature of the branches is a series of tufts or rosettes, so continuous and interwoven as in the main to present a whorl running successively round from base to apex, composed of a bunch of long parallel placed spicules, which issue from the axis of the branch at an oblique angle, and slightly spread out at their free ends. The spiral hollow between the frill shows a delicate gossamer lacework composed of minute spicules, forming a rectangular chequer."

The principal fibrous bands of the network of beams, which is composed of fused hexradiate spicules, run, according to Murie's representation, in a longitudinal direction in the axial part of the branches, but bend laterally in a bow-shaped curve towards the exterior, and terminate freely in the more radially directed obliquely projecting fibres of the spiral frill. All were covered with short mucronate spines.

Among the spicules which lie isolated Murie described (1) long acerate, fusiform, inequilateral spicules of two sizes, large and small, both covered with spines, all sloping in the same direction; (2) two forms of scopuline spicules, the larger with a straight shaft, and with microspined and indistinctly capitate terminal rays, from two to four in number, the smaller with two to four rays opposite to one another, and expanded laterally like petals.

In regard to the position of these scopuline spicules, Murie[1] records Carter's conjecture —illustrated by a woodcut—that they may have lain parallel to the surface in the dermal layer, and may have been crossed in such a way that square meshes were formed. He found (3) two forms of rosettes, of which the smaller bore six straight, smooth rays rising at right angles from the centre, and each terminating in a little discoid swelling bearing four to eight rays spreading in what Carter terms a *fleur-de-lis*. Each ray terminates in a swelling which is expanded into a circular convex head, bordered by four opposite and recurved spines. The larger rosettes are very rare, and the globular still more so. Each of the six short, stout rays terminates in a quadrangular swelling, which bears several long, straight rays, ending in a quadrangular, or, more frequently, pentangular cap or head, with free convex surface, but provided with recurved spines at the angles of the opposite surface. He also notes (4) single hexradiate dermal spicules, which form by the over-

[1] *Loc. cit.*, p. 227.

lapping of their horizontal rays the squares of the skin. The outermost tip of the exterior ray frequently bears the small rosette above described.

The most important peculiarities of the new form have been summarised by Murie in the following brief diagnosis;—"Hexactinellid sponge characterised by its dendritic or shrubby contour, occasionally attaining a height of 3 feet or possibly more. Branches forking or dichotomous, with continuous whorled series of spicular tufts from base to apices. Skeleton only known; basework composed of relatively stoutish glassy fibres of coalesced sexradiate and spinomucronate spicula, disposed in tolerably compact trabeculæ. Main direction of fibre longitudinal to axis in parallel, straightish, or slightly bent lines, where continued into exterior whorls; in crossing fibres more irregular, as are the very numerous excretory canals. Oscula and pores of moderate size distributed all over the free surfaces. Flesh-spicula abundant, and of scopuline, acerate, and rosette shapes. A dermal veil of slender interwoven Hexactinellid spicula probably clothes the major portion, or possibly the entire sponge."

In a postscript Murie finally calls attention to the fact that his *Dendrospongia steerei* may be identical with the *Sclerothamnus clausii*, Marshall, described a year before by Marshall,[1] so that the latter name must be accepted as the earlier.

To the memoir by Murie, Carter has added an appendix in which he expresses the opinion that the fragment from the basal tuft of *Euplectella cucumer*, which was at first referred by Bowerbank to *Farrea occa*, and later by Carter to *Farrea densa* as distinct from *Farrea occa*, and which was found to be rich in "scopuline spicules," is most probably to be referred to *Sclerothamnus clausii*.

Sclerothamnus clausii, Marshall (Pl. XCVIII.).

Of this remarkable bushy branched species, which differs essentially in external appearance from all known Hexactinellida, only two skeletal fragments belonging to a dead specimen were trawled by the Challenger Expedition in the neighbourhood of Timor (Station 194A, lat. 4° 31′ 0″ S., long. 129° 57′ 20″ E.), from a depth of 360 fathoms on volcanic mud. These are small, irregularly rounded, somewhat bent, and slightly knee-shaped branches of the thickness of one's finger, and from 12 to 15 cm. in length. The outer portion has been destroyed by abrasion or otherwise. The tolerably compact fibrous framework exhibits, in longitudinal section, strands of fibres for the most part longitudinally directed, or arched towards the exterior, and laterally curved. They terminate freely on the outer surface, while between them other fibres extend approximately at right angles. The entire disposition of the dictyonal framework, and especially the above-mentioned direction of the fibres, corresponds exactly with the structure of the framework described by Murie, and represented in a figure which has been copied here

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxv., Suppl.

on Pl. XCVIII. fig. 3. Moreover, the results of microscopic examination of the beams of the framework are in complete accordance with the description by Marshall and Murie. All the beams of the network, the meshes of which are not always quite regular, though generally square, are more or less richly beset with prongs which are either low and pointed, or larger, broader, and more acute, as shown in Pl. XCVIII. fig. 11. The whole framework is traversed by round canals, from 2 to 3 mm. in width, which open out laterally.

In the comparatively well-preserved large specimen studied by Murie, whose original figure I have copied on Pl. XCVIII. figs. 1, 2, and 4, ring-like or spiral wreaths were found to originate laterally on the branches of the stock, while between these bands of approximately uniform breadth occur. It is only in these wreaths that the extremities of the laterally bent longitudinal fibres of the dictyonal framework project freely (Pl. XCVIII. figs. 2, 4). Although, moreover, in the case of the specimen examined by Murie, only the deepened furrows were covered with a dermal lattice-like network of delicate hexacts, forming square meshes, he still regarded it as possible that the entire surface of the whole sponge was covered with such a dermal network.

Since I was able, in the British Museum, to examine some microscopic preparations, which were probably made from Murie's original specimen, and to compare the loose spicules preserved in great abundance, and partly in their natural position, with those which could be discovered here and there in the fragments from the Challenger Expedition, I was able to demonstrate the most complete agreement between the two forms. The identity of the species is therefore indubitable.

The slender hexacts of the dermal skeleton are covered with small pointed tubercles, especially on the extremities of the straight rays which run out to simple points. The distal ray is shorter, the proximal longer than the four equal intersecting tangentials. The outer extremity of every distal ray seems to be associated with a regular floricome-like hexaster. In the best preserved portions I found these on almost all hexacts of the dermal network (Pl. XCVIII. fig. 5).

Each of the six strong round and moderately short basal rays bears six terminals, which have the form of a liliaceous perianth, being slightly curved. They become gradually thicker towards the outer extremities, and finally terminate in a spherical knob. It seems to me noteworthy that these freely projecting spicules differ in the formation of the outer extremities of their terminal rays from the true floricomes of the Euplectellidæ, &c., though they agree in position and general form (Pl. XCVIII. fig. 6).

In addition to the dermal hexacts with radial axial ray, strong dermal scopulæ occur with rough shaft and four strong almost parallel teeth, which are likewise rough, and pass into a small terminal thickening (Pl. XCVIII. fig. 9).

Between the beams of the lattice-like dictyonal framework, strong uncinates occur

(Pl. XCVIII. fig. 10), and also the singular spicules already described by Marshall as aberrant broom-forks (Besengabeln), which indeed resemble the scopulæ in many respects, though not agreeing with them completely. The somewhat rough straight shaft, which runs out at one extremity into an abrupt point, is more or less richly beset with rough finger-like or conical teeth of variable size, and perpendicularly inserted. On the other somewhat thickened extremity it bears four, more rarely five or three, rough finger-like terminal rays, which diverge more or less markedly, and are, as a rule, slightly curved (Pl. XCVIII. figs. 7, 8).

It is improbable that the floricome-like hexacts with spherical terminal knobs, which are to be found in the dried specimens here and there between the beams of the network of the dictyonal framework, are to be regarded as parenchymal spicules. I am rather of opinion that they are accidental additions to the parenchyma, and derived from the skin.

Tribe II. INERMIA, F. E. Schulze (Pls. XCIX.–CI.; Pls. CIII., CIV.).

Dictyonina without uncinates and scopulæ.

Family MÆANDROSPONGIDÆ, Zittel (Pls. XCIX.–CI.; Pls. CIII., CIV.).

The body consists of a system of rounded, anastomosing tubes of tolerably uniform calibre, with a system of cavities between. Through the latter the water reaches the interior, passing through the wall of the tubes, and is passed out through their lumen either into the gastral cavity or directly to the exterior.

Genus 1. *Dactylocalyx*, Stutchbury (Pls. XCIX., C.).

1780. Rozier, Journal de Physique, October, t. xvi. p. 315, pl. i.
1781. Lichtenberg, Magazin für das Neueste aus der Physik und Naturgeschichte, Gotha, 1781, Bd. i. pp. 68, 69.
1841. Stutchbury, Proc. Zool. Soc. Lond., vol. ix. p. 86; Ann. and Mag. Nat. Hist., ser. 1, vol. ix. p. 504 (*Dactylocalyx pumiceus*).
1858. Bowerbank, Phil. Trans., vol. cxlviii. p. 279.
1859. Gray, Proc. Zool. Soc. Lond., vol. xxvii. p. 437; Ann. and Mag. Nat. Hist., ser. 3, vol. v. p. 495 (*Macandrewia*).
1860. Max Schultze, Hyalonema.
1861. Ehrenberg, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, vol. i. p. 448.
1862. Bowerbank, Phil. Trans., vol. clii. p. 747.
1863. Johnson, Proc. Zool. Soc. Lond., p. 257; Ann. and Mag. Nat. Hist., ser. 3, vol. xiii. p. 257.
1864. Bowerbank, Monograph of the British Spongiadæ, vol. i.
1864. Kölliker, Icones hist., Protoz.
1867. Gray, Proc. Zool. Soc. Lond., p. 492.
1868. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. i. p. 161.

1868. Claus, Ueber Euplectella aspergillum.
1869. Wyville Thomson, Phil. Trans., vol. clix. p. 701.
1869. Bowerbank, Proc. Zool. Soc. Lond., p. 66.
1869. O. Schmidt. Mittheil. Naturw. Vereines Steierm., p. 89.
1870. O. Schmidt, Grundzüge einer Spongienfauna des Atlant. Gebiet.
1871. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. vii. pp. 112-141, 268.
1872. Gray, Ann. and Mag. Nat. Hist., ser. 4, vol. ix. p. 442.
1873. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xii. p. 349.
1875. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xvi. p. 1.
1875. Marshall, Zeitschr. f. wiss. Zool., Bd. xxv., Suppl.
1875. Bowerbank, Proc. Zool. Soc. Lond., p. 272.
1876. Marshall. Zeitschr. f. wiss. Zool., Bd. xxvii. p. 113.
1877. Sollas, Ann. and Mag. Nat. Hist., ser. 4, vol. xix. p. 1.
1877. Sollas, Ann. and Mag. Nat. Hist., ser. 4, vol. xx. p. 285.
1877. Zittel, Abhandl. d. k. Baier. Akad. d. Wiss., Bd. xiii. p. 1.
1878. Zittel, Abhandl. d. k. Baier. Akad. d. Wiss., Bd. xiv. pp. 21-48, 65.
1879. Sollas, Journ. Roy. Micr. Soc., vol. ii. p. 122.
1879. Agassiz, Bull. Mus. Comp. Zoöl., vol. v. p. 289.
1880. O. Schmidt, Die Spongien des Meerbusens von Mexico.

History.—In 1841 a report was given by Stutchbury[1] on a sponge which was procured at Barbados, one of the Antilles, and which exhibited a siliceous skeleton composed of fine tubes with netted walls. The following diagnosis was proposed :—" Sponge fixed, rigid, siliceous ; incurrent canals uniform in size ; excurrent canals large, forming deep sinuosities on the outer surface, radiating from the root to the outer circumference." Stutchbury named it *Dactylocalyx pumiceus.*

Probably an illustrated notice which has passed from Rozier's Journal de Physique[2] into Lichtenberg's Magazine[3] also refers to the same genus. For a knowledge of this publication, which is chiefly of interest on account of the date of its publication, I have to thank Professor Marshall of Leipzig, who has sent me a copy of the text and of the figures. The title in Lichtenberg's Magazine[4] is in the following words :—" Nachricht von einem seltenen Polypengebäude." " The structure of the polype in the first copperplate shows a peculiar character and form not hitherto met with in any collection of the products of the sea. It is dazzling white, resembles a net, and the magnifying glass reveals a number of scattered chambers which are perforated in all directions ; it is therefore unusually light, and is very readily pulverised. Its elegant form approaches very near to that of the *Coupe de Neptune ;* but the resemblance is not confirmed when the two polype forms are placed side by side. It is difficult to refer this structure to its proper class. When kept under water it does not become larger, nor does it acquire any flexibility. With nitric acid it does not effervesce. When a piece of it is calcined

[1] *Proc. Zool. Soc. Lond.*, vol. ix. p. 86 ; *Ann. and Mag. Nat. Hist.*, ser. 1, vol. ix. p. 504.
[2] October 1780.
[3] *Magazin für das Neueste aus der Physik und Naturgeschichte*, Bd. i. pp. 68, 69, Gotha, 1781.
[4] *Loc. cit.*, p. 68.

it gives off, indeed, a smell like that of a burning animal body, but it does not expand like other lithophites. If it is heated in a crucible over a strong fire it smells like burned gore, assumes a darkish colour, and becomes finally dazzling white, so that it cannot, like the ordinary Madrepores, become transformed into lime. Nor does the residue vitrify by the application of strong heat. A portion of this form gave a yellowish colour to white oil of vitriol, which was due to the action of this acid on the animal part. The stone on which this structure is fixed, and which Mr. Badiez brought from Martinique, is a dense green lava mixed with crystals and dark prismatic schorl."[1]

In 1858, Bowerbank noted in the Philosophical Transactions (pl. xxvi. p. 312) some stellate spicules of *Dactylocalyx pumiceus*, Stutchbury, as examples of his "trifurcato-hexradiate stellate" and "spinulo-trifurcated hexradiate stellate spicules," and gave[2] a good figure of one of these.

The *Macandrewia azorica*, which Gray first described in 1859,[3] and which he united in a group along with *Dactylocalyx* and *Myliusia callocyathes*, does not belong, as later accurate descriptions show, to this category, being in fact a Lithistid. The same is true of *Dactylocalyx prattii*, Bowerbank, of which some typical skeletal spicules are figured,[4] as well as of *Dactylocalyx bowerbankii*, Johnson, which Johnson described,[5] and of which Bowerbank figured an isolated quadriradiate spicule in 1864 in his British Spongiadæ, vol. i. pl. ii. fig. 53.

In his great Sponge System Gray formed in 1867[6] a special family—the Dactylocalycidæ—within his order Corallispongia, and this family he characterised as "Sponges with massive, expanded, or flabellate, the network with angular meshes." The members of this family possess a "network irregular, not symmetrical," and consist of *Macandrewia* and *Myliusia* and of the genus *Dactylocalyx*, which was partly identified with *Iphiteon*, Valenciennes.

The diagnosis of *Dactylocalyx* is as follows:—"Sponge expanded, with large sunken groves and oscules on the upper and lower surface. Spicules of skeleton tuberculated; spicular network, rugose, tubercular. Sarcode with scattered, radiated, or stellate spicules, divided into branches near the base, and with knobs at the tip of the rays. Sarcode studded with many-rayed stellate spicules, the six principal rays diverging on all sides, and divided near the base into several elongated cylindrical linear rays, which diverge from each other and are tipped with a small apical knob like the head of a pin."

Besides the *Dactylocalyx prattii*, Bowerbank, which is a Lithistid, and does not therefore belong to this group, Gray established two other species of *Dactylocalyx*, namely,

[1] Rozier, *Journal de Physique*, October 1780, t. xvi. p. 315.
[2] *Loc. cit.*, fig. 1.
[3] *Proc. Zool. Soc. Lond.*, vol. xxvii. p. 432; *Ann. and Mag. Nat. Hist.*, ser. 3, vol. v. p. 495.
[4] *Phil. Trans.*, 1862, p. 747, pl. xxvii. fig. 8.
[5] *Proc. Zool. Soc. Lond.*, 1863, p. 257; *Ann. and Mag. Nat. Hist.*, ser. 3, vol. xiii. p. 257.
[6] *Proc. Zool. Soc. Lond.*, 1867, p. 505.

(1) *Dactylocalyx pumiceus*, Stutchbury, named *Dactylocalyx pumicea* by Gray, and identified with *Iphiteon panicea*, Valenciennes (Paris Museum), as a "sponge broad expanded, upper surface rather concave. Hab. West Indies, Barbados, St. Vincent;"[1] and (2) *Dactylocalyx subglobosus*, Gray, a "sponge subglobose, with a deep central concavity above; the outer surface with irregular anastomosing oscules. Hab. Malacca (?)" (pl. xxvii. fig. 1).

A short account of the nature of the continuous siliceous framework of *Dactylocalyx* was given by Claus in 1868 in his treatise on *Euplectella aspergillum*. He says on page 23:—"We have thus to deal here not with united siliceous spicules, but with a fibrous tress-work of siliceous substance like the ceratose fibrous networks which occur in the Ceratospongia." On the other hand, Wyville Thomson in the same year remarks,[2]—"I believe that it would be safe to accept the generalisation that the continuous siliceous network, wherever it occurs in the vitreous sponges, is produced by the fusion of spicules of the hexradiate type."

A detailed description of all these sponges which Bowerbank ascribed to the genus *Dactylocalyx*, Stutchbury, was given by the same author in 1869.[3] After first separating off the genus *Iphiteon*, Valenciennes, from *Dactylocalyx*, he characterised the genus *Dactylocalyx*, Stutchbury, in the following manner:—Skeleton siliceo-fibrous, fibres solid, cylindrical." *Iphiteon*, on the other hand, thus:—"Skeleton siliceo-fibrous, fibres solid, cylindrical. Reticulations symmetrical. Areas rotulate, confluent."

To *Dactylocalyx* he ascribed the following, in part, newly described species:—(1) *Dactylocalyx pumiceus*, Stutchbury; (2) *Dactylocalyx heteroformis*, Bowerbank; (3) *Dactylocalyx macandrewii*, Bowerbank; (4) *Dactylocalyx prattii*, Bowerbank; (5) *Dactylocalyx masonis*, Bowerbank; (6) *Dactylocalyx bowerbanki*, Johnson; (7) *Dactylocalyx polydiscus*, Bowerbank. Of all these, however, only the first, according to the figures and descriptions, namely, *Dactylocalyx pumiceus*, Stutchbury, is truly a Hexactinellid, all the others being Lithistida or Tetractinellida.

From Bowerbank's long description of *Dactylocalyx pumiceus*, Stutchbury, I shall quote only the diagnosis:—"Sponge cyathiform, slightly pedicelled, surface even. Oscula and pores unknown. Expansile dermal system, connecting spicula furcated attenuato-patento-ternate, and dichotomo-patento-ternate. Dermal membrane—tension spicula small, acerate and subequiangular triradiate spicula; retentive and defensive spicula acerate or cylindrical verticillately spinous, whorls of spines numerous and very large; and also attenuato-stellate, very minute and numerous. Skeleton:—rete irregular; fibre stout, irregularly and abundantly tuberculated, apices of the tubercles mainly papillous. Auxiliary skeleton-fibres more or less rectangular, hexradiate, profusely spinous, distal terminations clavate, large and numerous. Tension spicula

[1] Figured *loc. cit*, pl. xxvii. fig. 2.
[2] *Ann and Mag. Nat. Hist.*, ser. 4, vol. i. p. 122.
[3] *Proc. Zool. Soc. Lond.*, 1869, p. 76.

rectangular hexradiate, smooth, long and slender, radii subclavate. Retentive spicula trifurcated attenuato-hexradiate stellate, minute and very numerous. Gemmules membranous, aspicular." "Colour unknown in the living state. Hab.—Barbados (Dr. Cutting) Martinique, M. Pléc, 1829. Examined in the skeleton state."

Of the genus *Iphiteon*—a name which Bowerbank has ascribed to Valenciennes,[1]—Bowerbank accurately described five species in 1869,[2] namely, *Iphiteon panicea* (Valenciennes), Bowerbank, *Iphiteon beatrix*, Gray, *Iphiteon subglobosa*, Gray, *Iphiteon ingalli*, Bowerbank, and *Iphiteon callocyathes*, Gray.

The essential characters of the first species, *Iphiteon panicea*, are established by Bowerbank from a specimen obtained at Porto Rico, and preserved in the Museum of the Jardin des Plantes, Paris. The diagnosis reads as follows :[3]—"Sponge cyathiform, slightly pedicelled. Surface of rigid skeleton even. Oscula, pores and dermal membrane unknown. Skeleton symmetrically radial, radii short and stout, areas of the rete mostly six-sided spaces, within triangular ; fibre cylindrical, incipiently spinous. Tension spicula simple, hexradiate, slender, abundantly spinous, radii terminally more or less clavate. Rententive spicula spinulo-pentafurcated hexradiate stellate, few in number. Gemmules simple, membranous, subspherical, irregularly disposed, very numerous."

The second species, *Iphiteon beatrix*, Bowerbank, resembles *Aphrocallistes beatrix*, Gray, and has already been referred to in detail under the genus *Aphrocallistes*.

The third species, *Iphiteon subglobosa*, Bowerbank, agrees with *Dactylocalyx subglobosa*, Gray. Bowerbank diagnoses this form[4] as "a massive sponge, somewhat cyathiform, sessile ; surface uneven. Oscula and pores unknown. Dermal membrane—retentive spicula spinulated biternate minute, very numerous. Skeleton symmetrical radial ; areas confluent, somewhat irregular, mostly six-sided, spaces within triangular. Skeleton fibre at the external surface coarsely and irregularly tuberculated ; disposition of the tubercles sublinear. Auxiliary fibres rectangulated hexradiate, abundantly spinous ; radii spinulated. External defensive spicula fusiform acerate, very large and long, distal terminations occasionally incipiently spinous. Interstitial spicula rectangulated hexradiate, very slender, radii subclavate, basal ray very long. Spicula of the membranes retentive spicula spinulo-quadrifurcate and pentafurcate hexradiate stellate, numerous ; margins of the spinulate terminations crenulate."

The fourth species, *Iphiteon ingalli*, Bowerbank, agrees, according to Bowerbank himself, with *Dactylocalyx pumicea*, Gray, which is said to be distinct from *Dactylocalyx pumiceus*, Stutchbury. Bowerbank gives the following diagnosis[5]:—"Sponge cup-shaped. Rigid skeleton ; upper or exhalent surface with large intermarginal excurrent canals

[1] Valenciennes never really diagnosed a genus *Iphiteon*. The only foundation for this supposition is a preparation in the Museum of the Jardin des Plantes in Paris bearing a label as above. He cannot be referred to as the founder of the genus.

[2] *Proc. Zool. Soc Lond.*, 1869, pp. 323-357.

[3] *Loc. cit.*, p. 324.

[4] *Loc cit.*, p. 329.

[5] *Loc cit.*, p. 321.

radiating irregularly from the centre towards the circumference. Surface even. Oscula, pores and expansile dermal system unknown. Skeleton fibre stout, more or less furnished with scattered warty tubercles. Auxiliary fibres abundantly tuberculated, terminating spinulately. Insterstitial spicula rectangulated, hexradiate, large; radii nearly equal, attenuated and acutely terminated. Retentive spicula spinulo-quadrifurcate hexradiate stellate; terminal radii long."

The fifth form, *Iphiteon callocyathes* = *Myliusia callocyathes*, Gray, belongs to another genus, *Myliusia*, Gray, which will be described more closely below.

Oscar Schmidt[1] first called attention to the fact that the greater number of the forms described by Bowerbank as *Dactylocalyx* are not Hexactinellids at all, but belong to the Lithistida. According to Oscar Schmidt, the genus *Dactylocalyx* strictly embraces those sponges which are *characterised* by a triaxial type of spicule, "their siliceous network resembles neither the wide tubes of *Farrea* nor the prismatic tissues of *Aphrocallistes*, but a more dense irregular tresswork. The habit of the body may accordingly be very variable."

In addition to the meshed forms, *Dactylocalyx pumiceus* and *Dactylocalyx subglobosus*, Oscar Schmidt described and figured a third species, of very different appearance, under the designation *Dactylocalyx crispus*. From a short compact solid base, there rises a simple or divided funnel-shaped tube with a thin and somewhat folded wall, while the upper terminal opening appears to be either irregularly round or else sinuous and fissure like. Short tube-like lateral protuberances or branches which are here and there arranged in distinct longitudinal rows open to the exterior by a rounded aperture.

In an article on the classification of the sponges, published in 1872,[2] Gray distinctly curtailed his family of the Dactylocalycidæ as established in 1867. He removed the genus *Macandrewia*, which was regarded as representative of a special family, the Macandrewiadæ, retained the genera *Dactylocalyx*, *Myliusia*, *Kaliapsis*, and *Discodermia*, and characterised the restricted family as follows:—"Sponge massive or expanded or cup-shaped. Skeleton more or less regularly reticulated, with angular openings diverging from the centre."

In 1873 Carter[3] united *Dactylocalyx pumiceus*, Stutchbury, *Dactylocalyx pumicea*, Gray, and *Iphiteon pumicea*, Valenciennes, in his division of the Vitreohexactinellida, in the subdivision of "species massive, excavated, shallow," and in a family for which "rosettes or flesh-spicules, many rayed, rays of equal length, straight, capitate, sometimes only pointed," were said to be characteristic, while he formed a special family for *Dactylocalyx subglobosa*, Gray, with the following peculiarities:—"Rosette many rayed, rays of equal length, straight capitate, or with multitudinous rays of unequal

[1] O. Schmidt, Spongienfauna des Atlant. Gebietes, p. 18, 1870.
[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. ix. pp. 453-457.
[3] *Ann. and Mag. Nat. Hist*, ser. 4, vol. xii. p. 357.

length, straight and capitate, pappiform, or occasionally of the first kind once branched, or occasionally with echinated heads." The difference between *Dactylocalyx pumiceus*, Stutchbury, and *Dactylocalyx pumicea*, Gray = *Iphiteon ingalli*, Bowerbank, Carter found to consist in the fact that "the latter is charged, especially towards the surface, with long linear spicules (slender, fusiform, slightly inflated, and spined for some distance at each end), while these are not to be seen in *Dactylocalyx pumiceus*, Stutchbury.

In 1876 Marshall[1] placed the genus *Dactylocalyx* among his Pleionacidæ, and characterised it in the following words:—"Fused latticed tissue of little regularity. Free spicules are represented by rosettes and irregular hexradiate forms of unknown significance." As species, he noted (1) *Dactylocalyx pumiceus*, Stutchbury, and (2) *Dactylocalyx crispus*, O. Schmidt.

In 1877, in his paper on *Stauronema*,[2] Sollas referred *Dactylocalyx* and *Aphrocallistes* to his family of the Aphrocallistidæ, distinguished by "sex-radiate skeleton spicules with rays making any angle with each other," and in an article On the Action of Caustic Potash on the Siliceous System of Sponges,[3] he pointed out the irregular arrangement of the spicules in the skeletal framework of *Dactylocalyx pumiceus* and *Dactylocalyx subglobosus*.

In 1877, in his studies on fossil sponges,[4] Zittel referred *Dactylocalyx* with *Periphragella*, Marshall, and *Myliusia*, Gray, to his Mæandrospongidæ, which consist of meandering, entangled, and simple anastomising tubes or plates.

In the Journal of the Microscopical Society,[5] Sollas described a simple plain cup-shaped variety of *Dactylocalyx pumiceus*, Stutchbury, which he named *Dactylocalyx pumiceus*, var. *stutchburyi*, or simply *Dactylocalyx stutchburyi*. He called attention to the typical alternation of the outer and inner, or upper and under radial furrows or furrow-like depressions, described the continuous skeletal framework composed of united hexradiate spicules, and further some six-rayed, five-rayed, and simple spindle-shaped or thread-like isolated "flesh spicules." At the knots of these originally isolated six-rayed spicules, which are here united to the skeletal framework without recognisable order, Sollas frequently saw the beginning of a hollow octahedron, such as occurs in the Ventriculites. This was seen to become so completely covered by siliceous lamellæ that the knots in the older portions of the framework appeared to be solid throughout.

Among the Hexactinellida procured by the American Expeditions from the West Indies, and examined by Oscar Schmidt in 1880, several species of *Dactylocalyx* were found, which corroborated on the whole the opinions of Sollas. The form which had previously been described by Schmidt as *Dactylocalyx crispus* was now separated from the genus, and regarded as a young form of Schmidt's *Syringidium zittelii*.

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxvii. p. 122.
[2] *Ann and Mag. Nat. Hist.*, ser. 4, vol. xix. p. 1.
[3] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xx. pp. 285-300.
[4] *Abhandl. d. k. Baier. Akad.*, vol. xiii. p. 38.
[5] Vol. ii. pp 122-133.

Dactylocalyx pumiceus, Stutchbury, was found in the neighbourhood of Barbados at a depth of 103 fathoms; *Dactylocalyx subglobosus*, Gray, near St. Lucia, in 116 fathoms, and also to the north-west of Havanna in 190 fathoms.

As a new species Schmidt described a drinking-horn-shaped *Dactylocalyx* (*Dactylocalyx potatorum*) dredged from a depth of 190 fathoms near St. Lucia. Its wall measured 1·5 to 2·5 cm. in thickness, and consisted of a very light and fragile lattice-work of fine tubes. It also exhibited external as well as internal deep pittings, the openings of which alternate on the surfaces of the walls, and appear on the inner side to be arranged in longitudinal rows. Further, the form described by Gray as *Myliusia callocyathes* was referred by Oscar Schmidt to the genus *Dactylocalyx*.

Generic Characters.—The cup-shaped, thick-walled body exhibits both on the outer and on the inner surface irregular, but generally radial ridges, and interjacent furrows. Since internal furrows correspond to external ridges, the whole wall seems to be folded. It consists of a system of anastomosing, but mainly radial tubes, which open internally, and perhaps also externally. The system of spaces lying between these anastomosing tubes is closed on the internal gastral surface. It is probable that in the living form both the external dermal and the internal gastral surface of the entire sponge are covered by a flatly expanded dermal or gastral membrane. In the dermal membrane pentacts occur with unpaired hypodermal ray.

1. *Dactylocalyx pumiceus*, Stutchbury.

From the original description of Stutchbury, afterwards corroborated by Bowerbank and by Sollas in reference to two specimens from the Antilles Island, Barbados, and preserved in the Bristol Museum, *Dactylocalyx pumiceus* has a firm, flat, cup-shaped body, borne on a short, thick, massive stalk. It consists of a flat, plate-shaped roundish mass, 30 cm. in breadth, as thick as a thumb, and bordered by a slightly involute, slightly sinuous, rounded margin.

The radially-disposed furrows, which are frequently interrupted, alternate on the lower dermal and the upper gastral surface, and here and there exhibit dichotomous division. The very fine tubular network which forms the entire body is stone-like and very narrow in its meshes. The wall of the narrow tubes is composed of finely tuberculate beams, without thickening at the nodes of intersection.

Sollas found loose spicules in the parenchyma in the form of small hexacts, in which the slender rays were for the most part terminally thickened, while individual rays were frequently considerably elongated and somewhat curved. According to Bowerbank[1] the parenchyma includes oxyhexasters, with three long, slightly curved terminals on each of the six short principal rays, and also discohexasters with somewhat long terminals. The

[1] *Proc. Zool. Soc. Lond.*, 1869, p. 77, pl. iii.

dermal skeleton consists, according to Sollas, of numerous rough oxypentacts. No uncinates or scopulæ were found.

2. *Dactylocalyx subglobosus*, Gray (Pl. XCIX.).

Through the kindness of Professor O. Schmidt I obtained the half of an unfortunately much injured and partially macerated dried specimen of that sponge which Gray described in 1867 under the title *Dactylocalyx subglobosus*, and figured in the Proceedings of the Zoological Society of London, 1867, pl. xxvii. fig. 1. I was thus able to study the skeletal structure of this form. While I can, without further comment, simply corroborate the results of Gray and O. Schmidt as to the general form and macroscopic features, I have been led to some divergent conclusions as to the minuter structure. To these I must therefore briefly refer. Like Gray's specimen, and that figured by O. Schmidt in his Spongien des Meerbusens von Mexico (Taf. iv. fig. 8), the specimen lent me for examination, and represented from a photograph in the outer view in Pl. XCIX. fig. 1, exhibited a deep, thick-walled, pear-shaped cup, with a comparatively broad basis. The wall consists of a much folded plate. The clefts and furrows of the internal surface are narrower and more longitudinal than the more irregular cavities and furrows on the exterior.

While former investigators have seen in the folded plate, which forms the entire wall of the goblet, only a compact mass traversed by small round canals, I find it to be composed of a fine network of anastomosing tubes, 0·3 to 0·5 mm. in transverse diameter. The main direction of the tubes forming the framework is indeed radial to the surface of the entire sponge, but so many lateral branches of equal width are given off in every direction, anastomosing with adjacent tubes, that the whole appears as a thick and irregular felt-work. The cavities and interjacent spaces which occur between these anastomosing tubes, and, of course, communicate with one another in all directions, have the same diameter as the tubes. While I found this intercanalicular system of cavities closed on the inner gastral surface by a reticulated plate, I saw their free apertures here and there on the outer dermal surface. Here too, however, they are doubtless covered over by the delicate porous dermal membrane. The water streaming in from outside must find its way first into these interstitial spaces, then through the walls of the tubes into their lumen, and thence into the large gastral space, and perhaps also to the exterior by the dermal terminal apertures which are probably present during the life of the sponge. In fig. 2 of Pl. XCIX. I have given a diagrammatic representation illustrating my conception of the structure.

The dictyonal framework supporting the wall of these narrow tubes exhibits moderately strong irregularly tuberculate beams, with square, triangular, or round meshes without any definite regularity. The parenchyma includes, besides simple

tuberculate discohexacts, numerous discohexasters, in which each of the short simple principal rays bears four long terminals. These become gradually thicker towards the exterior, and finally end in a small compact transverse disc. The size of these discohexasters varies from 0·05 to 0·1 mm. in diameter.

The dermal membrane contains pentacts with rudiments of a sixth distal ray. The four tangentials end in a rough terminal knob, while the longer proximal radial is usually pointed (Pl. XCIX. figs. 3, 4).

Gray's original specimen is said to have been brought from Malacca (?). O. Schmidt obtained his forms from St. Lucia, West Indies, from a depth of 116 fathoms, and from lat. 23° 1′ N., long. 83° 14′ W., from a depth of 190 fathoms.

3. *Dactylocalyx* (?) *patella*, n. sp. (Pl. C.).

The completely macerated dictyonal framework displayed in Pl. C. fig. 1, probably belongs to a cup- or platter-shaped sponge, with walls at least a finger's-breadth in thickness. The tissue consists of an anastomosing network of tubes of very different calibre, varying from 2 to 4 mm. in width, and running in a generally radial or slightly curved course. As to the structure of the natural bounding surface nothing certain can be said.

The beams of the dictyonal framework, which form a network with approximately square or more irregular meshes, are moderately strong and quite smooth. Only the conical bosses projecting radially into the lumen of the canals or beyond its free bounding surface are beset with small pointed tubercles.

Since no loose spicules were found, it must remain somewhat doubtful whether the generic designation is correct.

Some specimens of this species were obtained by the Challenger Expedition off the coast of Portugal, others to the south-west of Bermudas, from a depth of 1075 fathoms, and coral mud ground.

Genus 2. *Scleroplegma*, O. Schmidt (Pl. CI. figs. 1, 2).

From the diagnosis which the author of this genus has given in his Spongien des Meerbusens von Mexico, p. 56, it unquestionably follows that the genus should be ranked in the family Mæandrospongidæ, Zittel. It seems to me doubtful, however, whether all the forms referred by O. Schmidt to this genus were really *Scleroplegmata*. On the contrary, from his own description, I am forced to conclude that his *Scleroplegma lanterna* and *Scleroplegma herculeum* belong to another set of forms. But with this I have not much to do, since I have not been able to examine the original specimens of these two species. I have, however, a half specimen of *Scleroplegma conicum*, Schmidt, which

though macerated has the dictyonal framework well preserved. This specimen, preserved by O. Schmidt himself, I have been able to use as a basis for an independent investigation of the genus and species.

I accept Schmidt's generic characters except in their last clause, which is based on the two doubtful species above referred to. In abbreviated form it reads as follows[1] :—"Sponges of cylindrical or truncated conical form, with a similarly shaped thick-walled body cavity. The peripheral felt-work is wide-meshed, but strong and firm, or brittle. It forms round or prismatic tubes, which generally run obliquely from the exterior to the interior, either isolated or united with one another, and opening into the gastral cavity. Between them irregular intercanals occur."

1. *Scleroplegma conicum*, O. Schmidt (Pl. CI. figs. 1, 2).

Of this species I could unfortunately procure only the single specimen figured from a photograph in Pl. CI. fig. 1. It was completely macerated, so that of the isolated skeletal elements no trace was left. The tubes, 2 to 3 mm. in width, which form the thick wall (5 to 8 mm.) of the cup-shaped body, are generally radial, and directed somewhat obliquely upwards and outwards. They open both on the internal gastral and on the external dermal surface by round apertures, and here and there exhibit anastomoses. The intercanals occurring between these anastomose abundantly, and have a uniform width; they open, however, only on the outer dermal surface, where the water enters.

The dictyonal framework consists of strong beams, superficially beset with small pointed tubercles, usually disposed in transverse rows. The nodes of intersection are spherically thickened and beset with pointed tuberculated warts, which are especially well developed in the bounding surfaces of the whole framework (Pl. CI. fig. 2). There is a remarkable absence of the conical bosses which, on the bounding surfaces of the dictyonal framework of other Dictyonalia, project for a variable distance at right angles to the nodes of intersection.

Scleroplegma conicum was found near Morrolight, West Indies, at a depth of 292 fathoms.

Genus 3. *Margaritella*, O. Schmidt.

Margaritella cœloptychioides, O. Schmidt (Pl. CI. figs 3–8).

From the somewhat indefinite figure and description which O. Schmidt gives of this form in his Spongien des Meerbusens von Mexico,[2] the body seems to exhibit a flat, cup-like form, resulting from a connected system of tubes. In the fragment which I received for comparison from Professor O. Schmidt, some free spicules were fortunately retained.

[1] *Loc. cit.*, p. 56.

[2] P. 54, pl. vii. fig. 7.

The slightly irregular dictyonal framework consists of moderately thick beams, somewhat uniformly beset with fine tubercles. The nodes of intersection exhibit no thickening, and on the bounding surface slender tubercle-like bosses of moderate length project freely (Pl. CI. fig. 3). The dermal membrane contains rough pentacts disposed regularly so as to form square meshes. In these spicules, the four uniformly long tangential rays end in a knot-like swelling, while the much longer proximal radial, which becomes narrower inferiorly, is simply rounded off or pointed. The parenchyma includes delicate oxyhexacts with somewhat undulating rays, which sometimes divide, and may also exhibit thickened points of intersection (Pl. CI. figs. 5, 6). More frequently sphæro-hexasters occur of variable size, and with a variable number of terminal rays. The principal rays are either moderately short, bearing six to eight knobbed terminals, about three times as long, somewhat markedly divergent and slightly curved (Pl. CI. fig. 8), or they are so shortened that they appear rather as a spherical thickening of the node of intersection. In the latter form the numerous, long knobbed terminal rays look like simple radii from a spherical centre (Pl. CI. fig. 7).

O. Schmidt notes that the form was dredged at Havanna, West Indies, from a depth of 158 fathoms.

Genus 4. *Myliusia*, Gray (Pl. CIII.).

1859. Gray, Proc. Zool. Soc. Lond., vol. xxvii. p. 437; Ann. and Mag. Nat. Hist., ser. 3, vol. v. p. 495 (*Myliusia callocyathes*).
1867. Gray, Proc. Zool. Soc. Lond., p. 492.
1869. Bowerbank, Proc. Zool. Soc. Lond., pp. 66, 334 (*Myliusia grayi*).
1870. O. Schmidt, Grundzüge einer Spongienfauna des Atlant. Gebiet.
1872. Gray, Ann. and. Mag. Nat. Hist., ser. 4, vol. ix. p. 442.
1873. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xii. p. 349.
1875. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xvi. p. 1.
1875. Marshall, Zeitschr. f. wiss. Zool., Bd. xxv., Suppl.
1876. Marshall, Zeitschr. f. wiss. Zool., Bd. xxvii.
1877. Carter, Ann. and Mag. Nat. Hist., ser. 4, vol. xix. p. 121.
1877. Sollas, Ann. and Mag. Nat. Hist., ser. 4, vol. xix. p. 43 (*Myliusia grayi*); and vol. xx. p. 285.
1877. Zittel, Abhandl. d. k. Baier. Akad.
1878. Marshall and Meyer, Mittheil. d. Zool. Mus. zu Dresden, Bd. ii. p. 261.
1879. O. Schmidt, Spongien der Meerbusens von Mexico, vol. i.
1880. O. Schmidt, Spongien der Meerbusens von Mexico, vol. ii.
1882. Weltner, Beiträge zur Kenntniss der Spongien.

History.—In 1859 Gray[1] described and figured a new sponge procured from the West Indies, which he regarded as representative of a new genus, and named *Myliusia*, with the specific name *callocyathes*.[2] The generic title was given in honour of Christlob Mylius, who was the first to describe the singular *Umbellularia groenlandica*. The

[1] *Proc. Zool. Soc. Lond.*, p. 439; *Ann. and Mag. Nat. Hist.*, ser. 3, vol. v. p. 497.
[2] Properly, *callocyathus*, from κύαθος, a cup.

description ran :—" Sponge siliceous, funnel-shaped, fixed by the base; the upper surface smooth, marked with numerous minute perforations placed in nearly parallel grooves, radiating from the centre to the circumference, and with numerous large, oblong, rather unequal-sized perforations, which are fringed on the lower side with a high wall of a similar structure to the rest of the sponge; these edges of the cavities causing the under surface to be covered with unequal irregular-shaped tubes of nearly the same length, and more or less confluent together: some of these tubes are simple and subcylindrical, others are expanded and more or less crumpled on the edge around the cavity, so as to end in two, three, or even four more or less circular mouths." A magnificent delineation of the elegant sponge completed this accurate diagnosis.

In the systematic review of the sponges, which Gray gave in the Proceedings of the Zoological Society London, in 1867, he placed *Myliusia* in the family of the Dactylocalycidæ (" sponge massive, expanded or flabellate, the network with angular meshes,") close to *Dactylocalyx*, and briefly characterised it on page 506 in the following words :— " The sponge conical, cup-shaped, pierced with numerous short truncated tubes, forming raised folded anastomising laminæ on the lower surface."

A diagnosis of the genus *Myliusia*, Gray, founded for the most part on the microscopic structure of the skeletal framework, was published by Bowerbank in 1869 in the Proceedings of the Zoological Society of London, part i. p. 66, and ran as follows :— " Skeleton siliceo-fibrous. Fibres solid, cylindrical. Rete symmetrical, disposed in a series of crypt-like layers parallel with the external surface, with intervening planes of perforated siliceous tissue."

Wyville Thomson,[1] in his scheme of Porifera vitrea, rejected Gray's genus *Myliusia*, and referred the form in question simply as *Dactylocalyx callocyathus* to the genus *Dactylocalyx*. Moreover, Bowerbank[2] subsequently found, "on microscopic examination of the structure of the type specimen of *Myliusia*, Gray," that it was identical with that of his genus *Iphiteon*. He therefore referred Gray's *Myliusia callocyathus*, as *Iphiteon callocyathus* to the genus *Iphiteon*. Thus, then, the generic name *Myliusia* became as it were free, and Bowerbank availing himself of the fact, designated another recently studied remarkable Hexactinellid from St. Vincent, West Indies, with the generic title *Myliusia*, and added to it the specific name *grayi*. The accurate description of the new species *Myliusia grayi*, Bowerbank, which was illustrated with two good figures of the microscopic structure of the skeleton, undoubtedly showed the essential difference between this species and Gray's *Myliusia callocyathus*, and certainly established the generic distinctness of the two. It is, however, very much to be regretted that Bowerbank did not invent a new name for his new genus, as many errors and ambiguities would thus have been avoided.

Later authors have, however, by no means always attended to the essential difference

[1] *Phil. Trans.*, p. 713, 1869.

[2] *Proc. Zool. Soc. Lond.*, p. 335, 1869.

between the two species *Myliusia* (*Iphiteon*, Bowerbank) *callocyathus*, Gray, and *Myliusia grayi*, Bowerbank, but without further inquiry have assigned both to the same genus *Myliusia*—a generic name which, after what has been said, ought to be applied to *Myliusia callocyathus*, and not to *Myliusia grayi*, Bowerbank, in case the latter of the two species does not belong to the same genus.

In 1873 Carter[1] established a characteristic difference between *Myliusia callocyathus*, Gray, and *Myliusia grayi*, with respect to the rosettes. In *Myliusia callocyathus*, the "rosettes are many rayed; rays of equal length, capitate, flexed, and grouped *en fleur-de-lis*, or occasionally with straight and capitate rays;" in *Myliusia grayi* "the rosettes are many rayed, rays of equal length, straight, capitate."

In the memoir which Marshall published in 1876 on the affinities of the Hexactinellida[2] he seemed inclined to identify *Myliusia callocyathus*, Gray, with *Dactylocalyx crispus*, O. Schmidt.

In the description of *Myliusia grayi*, Bowerbank, which Carter gave[3] in 1877, he notes that[4] "although *Myliusia grayi* presents the convoluted cerebriform appearance of *Myliusia callocyathus*, yet its minute structure is totally different, inasmuch as the knots or junctions of the fibre in the latter are solid and round, not hollow and lantern-shaped as in *Myliusia grayi*."

In his studies on fossil sponges Zittel[5] places *Myliusia grayi*—probably with exclusion of *Myliusia callocyathus*, Gray—along with *Dactylocalyx*, Stutchbury, and *Periphragella*, Marshall, in his family of the Mæandrospongidæ, "in which the sponge body consists of meandering, intertwining, and anastomosing thin-walled tubes or laminæ, the canal system absent or scarcely developed, the intercanal system, on the other hand, present. A covering layer is wanting, or forms a coherent siliceous skin on the surface."

In a report from the Dresden Zoological Museum (1878), Marshall and Meyer accurately described a new sponge from the Philippines as *Myliusia zittelli*, Marshall and Meyer. But since this form is doubtless closely related not to *Myliusia callocyathus*, but to *Myliusia grayi*, Bowerbank, we shall not at this stage take it into consideration (see *Aulocystis*). The species in question was found by O. Schmidt among the West Indian sponges of the American Expeditions.

1. *Myliusia callocyathus*, Gray (Pl. CIII.).

Specimens of this elegant species were procured from three stations by the Challenger Expedition, but of these none attains the size of the example described by J. E. Gray, and figured in the Proceedings of the Zoological Society of London, 1859, pt. xvi.

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 358.

[2] *Zeitschr. f. wiss. Zool.*, Bd. xxvii. pp. 113–136.

[3] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xix. pp. 126–131.

[4] *Loc cit.*, p. 128.

[5] *Abhandl. d. k. Baier. Acad.*, p. 38, 1877.

They are, however, in part very well preserved in alcohol, so one can learn something of the structure of the soft parts. The two specimens represented in natural size on Pl. CIII. figs. 1 and 2 (of which fig. 1 represents two individuals united into one) were obtained along with some fragments of other specimens, on blue mud ground, in the vicinity of Little Ki Island (Station 192, lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.) in 140 fathoms. A somewhat larger cup was procured in the neighbourhood of Timor (Station 194, lat. 4° 34′ 0″ S., long. 129° 57′ 30″ E.) on volcanic mud, at a depth of 200 fathoms; and a small dried specimen, only about 1 cm. in height, from St. Thomas, West Indies (Station 24, lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W.) on Pteropod ooze in 390 fathoms. All these specimens have the form of a thick-walled cup which expands upwards from a narrow basal plate.

The lateral wall consists of a plate from 1 to 3 mm. thick, which is simply folded and drawn out into radial open tubes. While in the small dried specimen from Station 24 these radial excurrent tubes of the gastral cavity are only 3 mm. broad, and are almost all isolated towards the exterior, in the larger specimens from Stations 192 and 194, they have a tolerable breadth (as much as 5 mm. or more), and are fused to one another laterally, so that they project externally in meandering lines or interwoven reticulate plates (Pl. CIII. figs. 1, 2). The free upper margin of the entire cup exhibits a sinuous external curvature. This is also true of the regular funnel-shaped large specimen (10 cm. broad, and 7 cm. high) figured by Gray (*loc. cit.*). The figure suggests that the radial tubes have originated through closure of the parietal folds by growth of the entire body. One may regard the entire upper aperture of the cup or funnel as the chief osculum, and the lateral orifices of the tubes as secondary or incidental oscula. At all events the water stream passes through the coherent plate in such a manner that it enters from the outside into the depressions, furrows, &c., between the radial tubes, permeates the continuous plate, and then reaches the lumen of the tubes which open out laterally, or the central space which is in open communication with these, and thus reaches the exterior, whether it be through the outer openings of the radial tubes, or through the large terminal aperture of the central (gastral) cavity.

The finer structure of the body is best studied in sections at right angles to the wall plate; one of these I have combined diagrammatically on Pl. CIII. fig. 3 from numerous preparations.

The dictyonal framework consists of moderately strong beams. These are beset with numerous small conical hooks, disposed in great part in regular cross rows. The beams are united with tolerable regularity, and form for the most part distinctly square, more rarely three-sided or five-sided meshes. The somewhat thickened nodes of intersection are provided with rough flat papillary rounded swellings. It seems to me noteworthy that on the (outer) dermal as well as on the gastral surface of the dictyonal framework the nodes of intersection which are here very richly provided with protuberant papillæ, are

to be contrasted with the corresponding nodes of most other Dictyonina in possessing, as a rule, *no* freely projecting radial ray, but simple slightly arched extremities (Pl. CIII. fig. 3).

The dermal skeleton contains hypodermal hexacts sometimes mixed with pentacts, and provided with smooth rays which are occasionally roughened at the extremities. Of these the distal ray, which is absent in the pentacts, is shortest, often simply rounded or even terminating in a small swelling, while the four tangentials which run out to a point, and the much longer proximal ray always taper to a point. On the outer extremities the hexact hypodermalia support a floricome-like discohexaster in which each of the short principal rays bears seven (more rarely fewer) S-shaped terminals, which run out externally into a thickened hemispherical transverse disc with a notched margin (Pl. CIII. figs. 7, 8, 9). The spicules which constitute the gastral skeleton have an exactly similar form and disposition (Pl. CIII. fig. 3).

Scattered throughout the dictyonal framework of beams I have also to note small simple hexacts with somewhat rough uniformly tapering rays (Pl. CIII. fig. 4), and oxyhexasters with short principals and long S-shaped pointed terminal rays (Pl. CIII. figs. 5, 6). Since there are two or three terminals on each principal ray, and since each of the six principals may either remain simple and undivided, or may be divided into terminals, all transitions occur between a hexact with five undivided somewhat rough rays and only the sixth ray forked, and an oxyhexaster in which each of the principal rays is divided into three terminals, giving a total of eighteen (Pl. CIII. fig. 5).

Genus 5. *Aulocystis*, n. gen. (Pl. CIV.).

History.—In his sponge-system Gray[1] added to the description of *Myliusia callocyathus*, the following brief notice :—" There are two smaller specimens in the British Museum which probably belong to the same species. The smaller one was collected by the Rev. L. Guilding at St. Vincent in 1840, and the other was received from the West Indies by Mr. Scrivener in 1842."

These specimens, which were not further studied by Gray, were subsequently examined by Bowerbank, who, in 1869,[2] gave the following account of them. While he maintained that the specimen procured by Mr. Scrivener in 1842 agreed in structure with *Myliusia* (*Iphiteon*, Bowerbank) *callocyathus*, Gray, " he found that the specimen collected by the Rev. L. Guilding at St. Vincent differed widely in the structure of its skeleton from either *Iphiteon*, Bowerbank, or *Dactylocalyx*. He proposed, therefore, to apply Dr. Gray's generic title *Myliusia* to this species, instead of to *Myliusia* (*Iphiteon*, Bowerbank) *callocyathus*, Gray. He accordingly named the form *Myliusia grayi*, and briefly diagnosed it as follows :—" Sponge sessile, massive. Dermal surface unknown. Surface

[1] *Proc. Zool. Soc. Lond.*, 1867, p. 506.
[2] *Proc. Zool. Soc. Lond.*, 1869, p. 335.

of rigid skeleton uneven and excavated. Oscula, pores and expansile dermal system unknown. Skeleton stratified, forming a series of expanded crypt-like spaces. Fibre cylindrical, incipiently or minutely spinous. Interstitial spicula numerous, acerate, large and long, variable in size, disposed in lines at right angles to the stratification in loose fascicula of two to four or five together. Retentive spicula spinulo-multifurcate, hexradiate, stellate."

The surface of the rigid skeleton exhibited a series of square or irregularly angular areas, the angles of which were occupied by *thin perforated* angle plates with their inner margins curved, so that, when combined, they left a large circular or oval orifice in the middle of each space. The mass of the oval sponge itself he found to consist of a series of thin sinuous skeletal plates, not more than one-third of a line in thickness. In sections of the rigid skeleton at right angles to the surface of the sponge, he found that "it was formed of a series of crypt-like layers of skeletal fibre, each layer forming as it were a distinct and extensive crypt-like space, with short, stout, cylindrical pillars with gradually expanded bases and capitals, the intervening portions of the shafts of the columns being irregularly studded with acutely conical incipient spines."

The two excellent figures which Bowerbank has appended to his description (*loc. cit.*, pl. xxiii. fig. 8. and pl. xxv. fig. 1), show more clearly than the description itself that the knots of the rectangular meshes of the beam network are perforated in a manner quite similar to the fossil *Ventriculites*. They exhibit in the interior a delicate hexradiate axial cross, but consist externally of siliceous strands, which correspond to the margins of a regular octahedron. This, too, was definitely stated by Carter in his description of the Hexactinellida in 1873.[1] "*Myliusia grayi*, both in generic form and structure, has many distinguishing characters, especially that which consists in an octahedral lantern-like appearance of the joints produced by the vitreous fibre stopping short of the joint, and proceeding thence directly on from one arm of the hexradiate spicule to the other, so as to leave the centre intact and visible through the interstices."

An exhaustive and accurate description of this *Myliusia grayi*, Bowerbank, was given by Carter in 1877.[2] Here he describes it as follows:—"General form hemispherical; general appearance enteromorphous or cerebriform, sessile, consisting of tortuous anastomosing tubular canals or passages separated by equally tortuous labyrinthic intervals. Tubular canals or passages now terminating on the surface in round patulous or long tortuous gutter-like openings. Surface of tubular passages, both externally and internally covered with a dermal layer of small sexradiate spicules, whose horizontal arms, overlapping each other, form a continuous quadrilateral meshwork. Internal or body structure of the wall of the tubular passages composed of lozenge-shaped or lantern-like knots of vitreous fibre applied end to end, three or more layers deep, thus forming a laminate mass of trapezoids united to each other at their angles in successive rows, with

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 365. [2] *Ann. and Nat. Mag. Hist.*, ser. 4, vol. xix. pp. 106-131.

cylindrical intervals between them covering each other more or less rectangularly. Skeleton spicules of three forms, viz., (1) small sexradiate, arms not inflated at their junction, alternately pointed, and thickly spined throughout; (2) much larger sexradiate, the same but with the arms slighted inflated at the extremity; (3) still much larger, unispined, but uneven on the surface, and here and there microspined. Flesh-spicules of two forms, viz., (1) rosette globular, consisting of six short arms, each of which is surmounted by five long capitate rays expanded in a vasiform manner; (2) bundles of minute hair-like undulating acerates like the tricurvate or low spicule."

"The small sexradiate," Carter continues, "become the centres respectively of the trapezoids, which are thus formed by the extension of a thread of *vitreous sarcode*, from one end of each of the arms of the sexradiate spicules to the other, strengthened at each attachment by subsiding threads and the arm of each end of the latter; finally increasing in thickness throughout till the trapezoid is fully formed and presents four sides, with eight lantern-like holes in them, one in each triangular face, through which the sexradiate form of the original spicule may be seen in the centre intact. Spicules 2 and 3 form the fringe round the apertures which interknits with the body structure of the lamina internally, the latter or the supposed acerate form extending beyond the former, both distally and proximally, while the flesh-spicules are scattered throughout the structure unequally, that is much more numerously towards the surface."

Although Carter clearly recognised the essential difference between *Myliusia callocyathus*, Gray, and *Myliusia grayi*, Bowerbank, their generic separation appeared to him unnecessary, perhaps because of the agreement in the "convoluted cerebriform appearance." He included both in the same genus *Myliusia*. Carter, however, called attention to the fact that although the skeletal structure of *Myliusia grayi* agrees very closely with that of many fossil Hexactinellids, such as *Scyphia*, *Ventriculites*, *Cœloptychium*, &c., yet "the general structure of *Myliusia grayi*, although convoluted, is massive and labyrinthic throughout, not cup-shaped or hollow in the axis, as that of *Ventriculites*, while *Cœloptychium* consists of radiating tubes, more or less branches round a hollow axis or stem, which in the horizontal section resembles *Ventriculites*."

On the other hand, Sollas described in the same volume of the Annals in 1877 a new fossil genus *Stauronema*, and assigned *Myliusia grayi* to the Ventriculitidæ, which are characterised by a "skeletal network having the nodes complicated by the presence of an octahedral lantern about each one."

In 1878 Marshall and Meyer[1] described a Hexactinellid from the Philippines closely related to, yet specifically distinct from, *Myliusia grayi*, Bowerbank. This they named *Myliusia zittelii*.

Of the three specimens examined, the best preserved exhibits a system of meandering folded funnels which have fused with one another, besides wider tubes with walls sup-

[1] *Mittheil. d. Zool. Museum, Dresden.*

ported by three to five layers of regularly coalescent hexradiate forms enclosing cubical meshes. Here, too, as in *Myliusia grayi* and in many fossil sponges, each ray of the hexradiate spicules is united at a certain distance from the node of intersection with one of the four adjoining rays by means of a siliceous bridge passing off at an angle of 45°, so that by means of these the appearance of an octahedral lantern with an internal axial cross is produced. Marshall, therefore, proposed the expressive name "lantern spicules." As to the oblique bridges between the arms of the central sexradiate spicules, Marshall was able to demonstrate their origin from the fusion of lateral hooks and prickles, which had become apposed to one another.

Among free spicules Marshall and Meyer found in the interior of the adult tissue scattered rod-like forms slightly bent at one end, and very small hexradiate rosettes, which bear on the extremity of each ray from four to six teeth, arranged like tulip petals. On the other hand, the covering of the soft parts contains on both sides of the tube-walls numerous four-, five-, and six-rayed spicules. On the upper slender margin of the walls of the tubes there was in some places a dense palisade row of smooth uniaxials, which are probably to be explained as a peristomial wreath. The relationship between *Myliusia* and *Cœloptychium* was particularly emphasised by Marshall and Meyer, but this difference was noted, that *Cœloptychium* is monozoic, *Myliusia*, on the other hand, polyzoic.

Oscar Schmidt also found the same species in the West Indian and Mexican region.[1] He adds to Marshall's description the observation that many nodes of intersection in the dictyonal framework of the specimens examined by him are unperforated. He found, however, a central cavity with which a markedly irregular plexus of externally opening tubes communicated. The meandering course of these tubes often makes it difficult to distinguish the canals and intercanals. Among the free skeletal elements he noted "prism rosettes."

Schmidt regarded *Myliusia* as a *Cystispongia* without a covering layer, and provided with conspicuous lantern nodes in the lattice framework.

To the genus *Cystispongia*, Roemer, Oscar Schmidt has assigned a new living form—*Cystispongia superstes.* He has given a careful account of the characteristics of the genus *Cystispongia* established by Roemer, and more accurately defined by Zittel, and of the single known species *Cystispongia bursa*, from the chalk, as also of the living *Cystispongia superstes* added by him.

1. *Aulocystis grayi* (Bowerbank), (Pl. CIV. fig. 7).

There is in the British Museum a dried round specimen about 2 cm. in breadth, and 1½ cm. in height, which Gray first described (1859 and 1867) as *Myliusia*

[1] Spongien des Meerbusens von Mexico, p. 52.

callocyathus, but which Bowerbank afterwards (1869) distinguished as *Myliusia grayi*. According to the label the form was found at St. Vincent, West Indies. Bowerbank briefly characterised it[1] in the following diagnosis:—" Sponge sessile, massive. Dermal surface unknown. Surface of rigid skeleton uneven and excavated. Oscula, pores, and expansile dermal system unknown. Skeleton stratified, forming a series of expanded crypt-like spaces. Fibre cylindrical, incipiently or minutely spinous. Interstitial spicula numerous, acerate, large and long, variable in size; disposed in lines at right angles to the stratification in loose fasciculi of two to four or five together. Retentive spicula spiculo-multifurcate hexradiate stellate." Bowerbank also gave[2] good figures of several specimens. From these two figures and from preparations which I was able to make during my stay in the British Museum at South Kensington, it can be distinctly seen that the dictyonal framework of *Aulocystis grayi* differs in several particulars from *Aulocystis zittelii*, Marshall. The most important difference consists in this, that on each of the nodes of intersection the octahedral edges are formed not of twelve simple, cylindrical, oblique buttresses, as in *Aulocystis zittelii*, but of twelve plates lying in the plane of the two connected axes, and perforated by several round or oval smooth margined holes of variable size. These plates expand to some extent in their different planes, so that in some places, especially on the free bounding surfaces of the entire dictyonal framework, conspicuous perforated siliceous membranes may be formed, as represented in one of Bowerbank's figures.[3] The small conical tubercles which occur all round the beams in *Aulocystis zittelii*, are here present in abundance on the freely projecting conical bosses, but elsewhere only on the edges of the perforated plates, and less abundantly, or not at all on the lateral surfaces of the same. The " long acerate interstitial spicules " of Bowerbank are slender, smooth, cylindrical needles which are disposed at right angles to the surface, and are in my opinion not free oxydiact parenchymalia, but the very much elongated proximal radial rays of the pentact dermalia.

Isolated parenchymalia are represented by numerous discohexasters with short principal rays, varying in size and in the number, strength, and length of the terminals. One of these is represented in Pl. CIV. fig. 7. Besides these I frequently observed bundles of those long and extremely fine terminal rays which characterise the graphiohexasters of *Aulocystis zittelii*. I found only a quite isolated occurrence of small simple oxyhexasters. I did not observe that special form of discohexaster with medium-sized principals which is so abundant in *Aulocystis zittelii* (Pl. CIV. fig. 6).

Consequently we are led to regard *Aulocystis grayi*, Bowerbank, as a form nearly related to *Aulocystis zittelii*, but yet different enough to be referred to a distinct species.

[1] *Proc. Zool. Soc. Lond.*, 1869, p. 335.
[2] *Loc. cit.*, pl. xxiii. fig. 8, and pl. xxv. fig. 1.
[3] *Loc. cit.*, pl. xxiii. fig. 8.

2. *Aulocystis zittelii* (Marshall) (Pl. CIV. figs. 1–6).

Two specimens of this remarkable Mæandrospongid were included in the rich collection of Hexactinellids trawled by the Challenger at Station 192, Little Ki Island, from a depth of 140 fathoms and a blue mud ground. They are fairly well preserved in spirit, have an oval form, and are about as large as a little man's fist. A smaller third specimen, dead but intact in form, was trawled off Banda Islands (Station 194A, lat. 4° 31′ S., long. 129° 57′ 20″ E.), from a depth of 360 fathoms and a volcanic mud ground. In form and size it resembles a hen's egg (Pl. CIV. fig. 2). The better preserved of the two other specimens is figured on Pl. CIV. fig. 1, in its natural size. It forms an oval, somewhat bulbous mass, 11 cm. in length, and 6·5 in greatest breadth. The outer surface consists of a thin, smooth, soft covering plate. In certain regions this plate exhibits irregular stellate clefts, while at others thin, translucent, and fine sieve-like perforated regions are seen, with an interjacent connected network of narrow, not translucent zones. Since not all the portions of this covering are preserved, it cannot be determined whether a round oscular aperture, which is suggested on the other specimens, is here really absent. Nor is it possible to discover the mode by which the sponge was fixed to its solid substratum, or its original position.

Traversing the entire internal space of this capsule is a well-preserved framework of irregular round tubes, a finger's breath in diameter, with firm walls 1 to 2 mm. in thickness, and exhibiting on both surfaces numerous small groove-like depressions of variable depth and breadth. From a median central space or short main passage, tubes which sometimes anastomose pass out radially to the external capsular plate, on which they are directly inserted transversely. These zones of insertion correspond to the non-translucent zones of the capsular covering plate, while the lumina of the tubes usually correspond to one of the round regions bearing a stellate cleft. Between this connected system of tubes there is a system of similarly anastomosing intercanals, which are covered over externally by the thin finely-perforated regions of the covering capsular plate (Pl. CIV. fig. 1). Through the latter the water passes from the exterior into the intercanalicular system, and through the tube-walls into the lumen of the anastomosing system of canal tubes, whence it regains the exterior through the clefts of the covering plate or through the oscular opening.

The connected dictyonal framework which supports the wall of the anastomosing tubes, is characterised by the great regularity of the lattice of beams which surrounds the strictly square meshes and corresponding cubical spaces. The simple nodes of intersection are furnished with twelve beams representing the edges of a regular octahedron. These beams extend as oblique buttresses between each two adjacent beams of the framework, at an angle of 45°, and at equal distances from the node of intersection. Both these buttresses and the freely projecting portions of the beams of the general framework

are furnished with numerous small tubercles and pointed elevations. The portions of the main beams, on the other hand, which lie within the space enclosed by the buttresses are perfectly smooth, and are not inconsiderably thinner than the outer portions of the beams (Pl. CIV. fig. 3). As Marshall and Meyer have noted in detail in the Mittheil. d. Zool. Museums, Dresden (1877), the oblique buttresses round about the nodes of intersection are really spine-like processes of the main beams, growing out in a given direction from the external surface of two adjacent beams, until they finally meet and fuse with one another. That they are in fact simple spines is further demonstrated by the fact, which Marshall and Meyer have emphasised, that they have no axial canals, which can be distinctly detected, on the other hand, in all the beams of the main framework, and even on those thin portions which are enclosed by the lantern-like arrangement of the buttresses.

It need hardly be noted that here also the entire quadrate lattice-work is built up of single hexacts, in which the corresponding parallel rays are enclosed in a common siliceous sheath, and thus united.

Here and there, especially near the bounding surfaces, there are also simple, solid, slightly thickened nodes of intersection in the dictyonal framework.

The covering plate which encloses the sponge as in a capsule, apparently arises from the outward bending of the tube-wall at right angles, or in a trumpet-like curve. This is distinctly seen in the macerated specimen represented in Pl. CIV. fig. 2. In the two larger specimens it contains no connected skeleton, while in that trawled off Banda Islands (Pl. CIV. fig. 2), it is supported over a large extent by a dictyonal framework, which corresponds exactly to that of the tubular network, and is in fact a direct continuation of the latter.

In this form, better than in those obtained off Little Ki Island, a double principal canal can be seen, which seems to have opened with a free margin at the narrower end (Pl. CIV. fig. 2).

Sections through the wall of the tube show distinctly in many cases the structure of the soft parts. The deeply folded chamber layer is connected to the dermal membrane by a somewhat uniformly developed external trabecular framework, which extends also into the afferent clefts and passages. The internal trabeculæ, on the other hand, only extend between the sieve-like gastral membrane and the internally projecting folds of the chamber-layer (Pl. CIV. fig. 3), without being to any marked extent continued into the efferent canals. The chambers themselves are comparatively small and simply thimble-shaped.

The capsule has an average thickness of 0·3 mm., and exhibits between the outer and the inner porous limiting membrane numerous passages and vesicular cavities, but in the Little Ki specimens, at least, no chambers.

As to loose spicules, I found in the parenchyma between the chambers in the tra-

becular network :—(1) simple oxyhexasters which are always beset with pointed spines; (2) discohexasters of various sorts, including isolated forms with short principal rays and six to ten long markedly divergent terminals, in some cases strongly developed (Pl. CIV. fig. 7), and in others quite thin and delicate (Pl. CIV. fig. 5). There is, on the other hand, a very abundant occurrence of discohexasters in which each of the long principals bears a tuft of six to ten, slightly divergent, fine, moderately long terminals (Pl. CIV. fig. 6). Here and there (3) graphiohexasters occur, with short principal rays and very long, extremely delicate, slightly undulating terminals, which form a loose divergent tuft on each principal (Pl. CIV. fig. 4). In some places as a support to the dermal membrane of the tubes, moderately strong oxypentacts occur with a hypodermal radial ray, usually somewhat elongated. While the internal portion of their rays is usually smooth, the outer ends are more or less abundantly beset with pointed tubercles. A rounded-off rudiment of a sixth (distal radial) ray is of very frequent occurrence, and of variable size. In structure and size resembling these hypodermalia, hypogastral pentacts occur with their tangential rays in the gastral membrane. On the external limiting membrane of the capsule there is a layer of hypodermal pentacts which entirely resemble those above described. On the inner surface of the capsule there is in many places no special skeleton, while other regions exhibit a layer of large oxypentacts with toothed ends to the rays, and arranged in contrast to the former pentacts with the radial unpaired ray directed outwards. The strands of tissue between the two parallel limiting lamellæ of the capsule contain either no spicules at all, or in certain positions somewhat long straight rough diacts, with central swelling, and pointed or slightly rounded toothed extremities.

BRIEF SYSTEMATIC SURVEY OF THE HEXACTINELLIDA DESCRIBED IN THIS REPORT.

Order HEXACTINELLIDA or TRIAXONIA.

Sponges with very loose soft parts, and with siliceous spicules, which are either isolated or united into a connected framework, and belong or are reducible to the triaxial system.

Suborder I. LYSSACINA, Zittel.

Hexactinellida in which the spicules either remain altogether isolated, or are in part subsequently and irregularly united by siliceous masses or transverse synapticula.

Tribe I. HEXASTEROPHORA, F. E. S.

Hexasters are always present in the parenchyma. The ciliated chambers are sharply separated from one another, and are thimble-shaped.

Family I. Euplectellidæ, Gray.

The dermal skeleton contains sword-shaped oxyhexacts with long proximal ray.

Subfamily 1. Euplectellinæ, F. E. S.

Tubular forms with transverse terminal sieve-plate. The lateral wall exhibits circular parietal apertures. The projecting distal ray of the dagger-shaped hexact dermalia bears a floricome.

Genus 1. *Euplectella*, Owen.

With basal root-tuft. Parenchymal oxyhexasters.

Species 1. *Euplectella aspergillum*, Owen.

Somewhat curved tube, slightly widened towards the upper end, bearing external ridges and cuff-like fringe. Circular parietal gaps alternate with closed meshes, and are disposed in spiral rows, ascending at an angle of 45°. The principal supporting spicules of the square-meshed framework are *oxytetracts*. The annular membrane round the parietal gaps contains strongly developed compressed oxypentacts. Zebu (Philippines); 95 fathoms.

Species 2. *Euplectella suberea*, Wyville Thomson.

Straight, somewhat bulging tube, without ridges or cuff. Circular parietal gaps alternate with closed arched meshes, and are spirally arranged, ascending at an angle of 45° The principal supporting spicules of the loosely united meshed framework are strongly developed *oxypentacts* with distal radial ray. *The annular membrane of the parietal gaps contains straight knotted diacts and sceptres.* West of Gibraltar, 600 to 1090 fathoms; north-east of Bahia, 1600 fathoms; off the Berlingues, 1600 fathoms.

Species 3. *Euplectella cucumer*, R. Owen.

Straight, somewhat bulging tube, without ridges or cuff. Circular parietal gaps alternate with closed arched projecting meshes, and are disposed in spiral rows, ascending at an angle of 45°. *The summit of each protruding arched mesh bears the projecting distal ray of a strongly developed oxyhexaster.* Seychelle Islands.

Species 4. *Euplectella jovis*, O. Schmidt.

Straight tube, somewhat widened towards the upper end, without external ridges, but with a terminal marginal cuff. Round parietal gaps occur in approximately regular spiral rows. The principal supporting spicules of the square-meshed framework are strongly developed oxypentacts, with long projecting distal ray. The annular membrane of the parietal gaps contains sceptres and S-shaped clasps. Antille Islands, 423 fathoms.

Species 5. *Euplectella oweni*, Marshall.

Straight phallus-shaped tube, with *oval* cross section, without ridges or cuff. Circular parietal gaps arranged in *longitudinal and transverse rows.* The principal supporting spicules of the square-meshed framework are strong *oxytetracts.* The annular membrane of the parietal gaps contains *compass-shaped oxydiacts* disposed tangentially. Japan.

Species 6. *Euplectella crassistellata*, n. sp.

The principal parenchymal spicules (principalia) are long smooth oxydiacts with knotted thickening in the centre. The parenchymal oxyhexasters have strikingly thick and somewhat long principal rays, each with four moderately short terminals. Middle of Pacific, 2750 fathoms.

Species 7. *Euplectella* (?) *nodosa*, n. sp.

Straight slightly bulging tube (with irregular parietal gaps), without external ridges. The principalia are strong oxypentacts, in which the distal ray does *not* project beyond the external surface. In some dermal oxypentacts the floricome is replaced by a tuft of oxydiacts with central nodes. Instead of the ordinary oxyhexasters, lophohexasters occur. Possibly belonging to the genus *Holascus*. Bermuda Islands.

Genus 2. *Regadrella*, O. Schmidt.

A tubular form firmly attached by means of a knobbed basal portion.

Species 1. *Regadrella phœnix*, O. Schmidt.

The principalia are large oxypentacts, which have their four tangential rays variously disposed in different directions. Parenchymal discohexasters with short principal and long terminal rays. Antille Islands, 221 to 280 fathoms.

Subfamily 2. HOLASCINÆ.

Tubular. Without *parietal gaps*. Without superficially situated floricomes. Parenchymal oxyhexasters.

Genus 1. *Holascus*, n. gen.

With root-tuft and transverse sharply defined terminal sieve-plate. The internal gastral surface bears projecting longitudinal and transverse lattice-work ridges. Hypodermalia, sword-shaped hexacts with short *rough* distal ray, besides which oxydiacts are radially apposed.

Species 1. *Holascus stellatus*, n. sp.

Principalia are oxypentacts with distal radial ray, or rarely oxyhexacts. The parenchyma includes oxyhexasters, some with straight, and others with long curved terminals. Graphiohexasters and probably discohexasters also occur. The hypogastralia resemble the hypodermalia. Buenos Ayres, 2650 fathoms.

Species 2. *Holascus fibulatus*, n. sp.

The principalia are oxytetracts. Small oxyhexacts more externally. The parenchyma includes, besides the oxyhexasters, numerous markedly curved two- (or frequently three-) rayed fibulæ. The gastralia are oxypentacts without inwardly projecting radial ray. South of Australia, 2600 fathoms; west of Crozet Islands, 1375 to 1600 fathoms.

Species 3. *Holascus polejaevii*, n. sp.

The principalia are oxyhexacts with long, sometimes curved, tangential rays. The parenchyma contains, besides the simple oxyhexasters, other forms in which the principal rays are externally thickened, and bear tufts of strongly developed terminals. The gastralia are somewhat large oxypentacts without freely projecting radial ray. South of Australia, 1950 fathoms.

Species. 4. *Holascus ridleyi*, n. sp.

The principalia are substantial oxytetracts. The parenchyma includes, besides the ordinary oxyhexasters, other forms in which the principal rays are much thickened externally, and bear tufts of strong terminals. Simple oxyhexasters with curved terminal rays have also an occasional occurrence. The gastralia are slender oxyhexacts. Philippines, 2225 fathoms.

Genus 2. *Malcosaccus*, n. gen.

Sack-like or tubular forms with loose walls, externally somewhat smooth, and internally honeycombed. The principalia are oxyhexacts with very long, thin, pliable tangential rays. The hypodermalia and hypogastralia are sword-shaped hexacts with rough projecting ray, which perhaps bears a floricome.

Species 1. *Malacosaccus vastus*, n. sp.

The parenchyma contains oxyhexasters with very fine long terminal rays, and small discohexasters with many terminals on the transverse disc-shaped terminal expansion of each principal ray. West of Crozet Islands, 1375 fathoms.

Species 2. *Malacosaccus unguiculatus*, n. sp.

Besides numerous oxyhexasters with fine straight or curved terminal rays, the parenchyma contains discohexasters with three or four long and slightly curved terminal rays on each principal. The terminal rays of the floricomes only exhibit two to three strongly developed terminal claws. South of Sierra Leone, 2450 fathoms.

Subfamily 3. Tægerinæ, F. E. S.

The thin wall of the sack-like or tubular body is penetrated by parietal gaps of irregular shape and distribution. The skeletal lattice-work of the wall usually forms an irregular meshwork. Each projecting distal ray of the sword-shaped hypodermalia bears a floricome.

Genus 1. *Tægeria*, n. gen.

With the single species, *Tægeria pulchra*, n. sp.

A rigid sack-shaped body firmly attached by means of a knotted base. Irregular roundish parietal gaps. The superior round terminal aperture exhibits an external wreath of short straight, and an inner crown of long arched spicules. The principalia are oxytetracts, oxytriacts, and oxydiacts. The parenchyma contains discohexasters and discohexacts. Graphiohexasters occur near the outer skin. The dermal skeleton contains slender hypodermal oxyhexacts. The gastral skeleton consists of strongly developed pentacts. Fiji Islands, 610 fathoms.

Genus 2. *Walteria*, n. gen.

With the single species, *Walteria flemmingii*, n. sp.

The wall of the sack-shaped body consists of a lattice-work with irregularly angular meshes of various size and form. It is continued at one end into a funnel with square meshes. The distal ray of the hypodermalia is thickened and rounded off. The parenchyma contains discohexasters with many, and others with few terminal rays. The floricomes have numerous (fifteen) terminal rays on each principal. North of Kermadec Islands, 630 fathoms.

To the Euplectellidæ are also to be referred the following seven genera, which have not as yet been sufficiently investigated.

Genus 1. *Habrodictyum*, Wyville Thomson.

With the single species, *Habrodictyum speciosum* (Quoy and Gaimard).

Tubular forms with irregular parietal network, firmly attached by a knotted basal portion. The lateral wall is directly continued without definite margin or cuff into the uniform gently arched terminal cupola. The parenchyma contains oxyhexasters with medium-sized principal rays and short terminals. Molucca Islands.

Genus 2. *Eudictyum*, Marshall.

With the single species, *Eudictyum elegans*, Marshall.

The terminal sieve-plate is distinct indeed from the lattice-work of the tubular parietal skeleton, but is not markedly different. The parenchyma contains small discohexacts.

Genus 3. *Dictyocalyx*, n. gen.

With the single species, *Dictyocalyx gracilis*, n. sp.

A funnel-shaped skeletal network with altogether irregular meshes, firmly attached to a substratum by means of a solid compact stalk. The parenchyma includes several kinds of discohexasters, some of which bear on their terminal rays marginally toothed convex discs, and others lacerate campanulate terminal umbels. South Pacific, 2385 fathoms.

Genus 4. *Rhabdodictyum*, O. Schmidt.

With the single species, *Rhabdodictyum delicatum*, O. Schmidt.

A very lank almost tubular cup, borne on a small compact basal plate. The parietal skeleton is traversed by round smooth holes, and consists of irregularly disposed long-rayed hexacts which are cemented together. Bequia, 1591 fathoms.

Genus 5. *Rhabdopectella*, O. Schmidt.

With the single species, *Rhabdopectella tintinnus*, O. Schmidt.

A firmly attached cup with skeletal beams cemented together below, but consisting superiorly of free and isolated spicules. The parenchyma contains the usual oxyhexasters, and also other forms in which the strong terminal rays appear to spring from a central

node as the result of the disappearance of the principals. Discohexasters also occur in which the long lank curved terminals bear on their thickened external end a marginally toothed convex disc. Other discohexasters occur with five terminal rays on each moderately short principal. Of the five lacerate campanulate terminal discs of these terminal rays, the four outer are always markedly larger than the central. Rough, somewhat spirally curved diacts also occur. Antille Islands, 994 fathoms.

Genus 6. *Hertwigia*, O. Schmidt.

With the single species, *Hertwigia falcifera*, O. Schmidt.

An irregular lattice-work labyrinth is borne on a firmly attached knotted base. Some of the parenchymal hexasters bear on each of the short principal rays four sickle-shaped hooks representing terminals. Antille Islands, 611 fathoms.

Genus 7. *Hyalostylus*, n. gen.

With the single species, *Hyalostylus dives*, n. sp.

A long slender stalk bears a soft folded cup of a somewhat flattened, or triangular bilaterally symmetrical form. The two larger smooth lateral surfaces pass by a rounded edge into one another, while the third narrower side is folded. Besides thread-like diacts with swollen roughened ends, the parenchyma includes four different forms of rosettes, in which the terminal rays either terminate in long cylindrical clubs, or in terminal claws with convex terminal discs. Besides these, rough slightly spiral diacts occur. South Pacific, 2550 fathoms.

Family II. Asconematidæ, (Gray).

The dermal and gastral skeletons contain pentact or hexact pinuli. The hypodermalia and hypogastralia are pentacts. With parenchymal discohexasters.

Subfamily 1. Asconematinæ, F. E. S.

Cup-, funnel-, or tube-shaped forms borne on a stalk. The wall has the form of a thin loose plate.

Genus 1. *Asconema*, Sav. Kent.

With the single species, *Asconema setubalense*, Sav. Kent.

Funnel-shaped form. The principalia are long diacts. Between these in the paren-

chyma small oxyhexacts, oxyhexasters, and discohexasters occur. The pinuli are for the most part pentacts. West of Portugal, Morocco and Scotland, 200 to 400 fathoms.

Genus 2. *Aulascus*, n. gen.

With the single species, *Aulascus johnstoni*, n. sp.

Tubular form. The principalia are oxyhexacts and diacts. Between these in the parenchyma discohexasters and single plumicomes occur. On the dermal and gastral pinuli the ray turned towards the parenchyma is more or less developed. Prince Edward Islands, 310 fathoms.

Subfamily 2. Sympagellinæ, F. E. S.

Ovoid, thick-walled, usually (or always?) stalked goblets with smooth, thin superior margin. The parenchyma between the principal hexacts and diacts contains small discohexasters.

Genus 1. *Sympagella*, O. Schmidt.

With the single species, *Sympagella nux*, O. Schmidt.

On the terminal branches of a ramified stock ellipsoidal goblets are borne. The parenchyma contains, besides isolated plumicomes, numerous discohexasters with two to four delicate terminal rays on each principal, and also small elongated stars. Florida, 98 to 123 fathoms; coasts of Spain and Portugal; Cape Verde Islands, 100 to 128 fathoms.

Genus 2. *Polyrhabdus*, n. gen.

With the single species, *Polyrhabdus oviformis*, n. sp.

Unstalked (?). Egg-shaped goblet slightly narrowed superiorly. The dermal pinuli are hexacts with thick scaly distal ray. The parenchyma contains discohexasters with numerous terminal rays. South Indian Ocean, 1975 fathoms.

Genus 3. *Balanites*, n. gen.

With the single species, *Balanites pipetta*, n. sp.

Obliquely stalked. The parenchyma contains numerous small discohexacts. The dermal and gastral pinuli are hexacts with compressed, scaly, freely projecting ray. On the superior oscular margin they are directly continuous. Besides the small discohexacts, the parenchyma also includes discohexasters with long principal rays, which bear a tuft of short terminals. South Indian Ocean, 1950 fathoms.

Subfamily 3. Caulophacinæ, F. E. S.

Mushroom-like, with long, cylindrical, hollow stalk.

Genus 1. *Caulophacus*, n. gen.

The dermal surface of the body, which is flattened from above downwards, is either slightly convex or has become concave by the downward folding of the marginal portion of the flat body, The projecting ray in the dermal pinuli is short and broad, but long and weakly developed in the gastral.

Species 1. *Caulophacus latus*, n. sp.

The body consists of a flat circular disc with a downward-folded sharp-edged margin. The long cylindrical stalk passes by a trumpet-shaped expansion into the middle portion of the disc. The parenchyma contains discohexacts, oxyhexasters, and numerous discohexasters. The short dermal pinuli are almost all hexacts, the long gastral pinuli are, on the other hand, pentacts. West of Crozet Islands, 1600 fathoms.

Species 2. *Caulophacus elegans*, n. sp.

The disc is either biconvex, or with down-turned marginal portion convex-concave. The parenchyma contains, besides numerous discohexacts, also four-rayed discohexasters. The dermal and gastral pinuli are hexacts. The radial rays of the hypodermal pentacts are toothed. East of Japan, 2300 fathoms.

Genus 2. *Trachycaulus*, n. gen.

With the single species *Trachycaulus gurlittii*, n. sp.

The long stalk is covered with long pointed dermal pentact pinuli, and contains as principalia long diacts which lie parallel in longitudinal series, and are firmly united by means of synapticula. Subdermally large sickle rosettes occur, with four terminal rays on each principal. South Pacific, 2550 fathoms.

Family III. Rossellidæ, F. E. S.

The dermalia are always without a distal radial ray.

Genus 1. *Lanuginella*, O. Schmidt.

With the single species, *Lanuginella pupa*, O. Schmidt.

The body forms a cocoon-shaped, thick-walled sack with superior circular aperture, and is directly attached by its blunt lower end. The parenchyma contains delicate discohexasters, plumicomes, and small discohexasters with numerous terminal rays on the broad terminal discs of the principals. Cape Verde Islands; Little Ki Island, 140 fathoms.

Genus 2. *Polylophus*, n. gen.

With the single species, *Polylophus philippinensis* (Gray).

The cup-shaped, thick-walled body, provided with a wide circular oscular aperture, is rooted in the mud by means of a basal tuft. The external surface bears spherical papillæ, from the rounded summit of which a tuft of long pleuralia projects. From the papillæ buds are frequently developed. The parenchyma contains numerous oxyhexasters with long rough principal rays, each with three long markedly diverging terminals. Single plumicomes also occur. In the skin, above the medium-sized hypodermal oxypentacts, there lie small, rough, somewhat incurved, cruciate autodermal tetracts. The pleuralia and basalia pass inferiorly into anchors with four slightly curved transverse teeth. Little Ki Island, 140 fathoms.

Genus 3. *Rossella*, Carter.

Thick-walled goblets of an egg- or barrel-like form, with circular oscular aperture and deep gastral cavity. From regularly distributed small boss-like elevations of the external surface a group of diact and pentact pleuralia project radially outwards, and by the association of their tangential rays form a kind of veil. By a deep but regular and simple folding of the chamber layer, alternating afferent and efferent, narrow, funnel-shaped, radial canals are formed. The parenchyma contains oxyhexasters with very short principal rays and various discohexasters. In the dermal membrane rough pentacts almost exclusively occur.

Species 1. *Rossella antarctica*, Carter.

Elongated egg- or barrel-shaped forms, firmly fixed or rooted among small stones by means of short processes. The tangential rays of the pleural pentacts are so displaced to

one side that the outermost do not include much more than a right angle. The parenchyma contains oxyhexasters with long terminal rays disposed in a perianth-like fashion. South-east of Prince Edward Island, 140 fathoms; south of Kerguelen, 150 fathoms; east of Buenos Ayres, 600 fathoms.

Species 2. *Rossella velata*, Wyville Thomson.

At the base tufts of long basalia project like the pleural tufts, and unite into a root anchoring the sponge in the mud. The four tangential rays of the pleuralia are crossed at right angles. The basalia end in anchors, the four teeth of which are somewhat markedly recurved. The parenchyma contains plumicomes. West of Gibraltar, 651 fathoms.

Genus 4. *Acanthascus*, n. gen.

Thick-walled goblets firmly attached by the blind lower end. The gastral cavity opens superiorly by a simple smooth-margined round oscular aperture. Diact pleuralia project radially on the sides. The parenchyma contains oxyhexasters and discohexasters in varied form. The dermalia are small rough tetracts and pentacts.

Species 1. *Acanthascus grossularia*, n. sp.

The pleuralia project as isolated spicules, so that the egg-shaped body comes to resemble a gooseberry. The parenchyma contains discohexasters in which numerous terminals are borne on the broad terminal plate of the principal rays, while others have the long terminals arranged in perianth-like fashion. The dermalia are for the most part tetracts, though pentacts also occur. The gastralia are spinose oxyhexacts. Possession Island, 210 fathoms.

Species 2. *Acanthascus dubius*, n. sp.

The parenchyma contains oxyhexasters in which the long terminal rays seem to spring directly from the central node, as the result of a marked shortening of the principals. Besides these, discohexasters occur with short principal rays. The dermalia are pentacts, the gastralia are rough oxyhexacts. South of Puerto Bueno, in Patagonia, 400 fathoms.

Species 3. *Acanthascus cactus*, n. sp.

From numerous gentle elevations on the external surface, tufts of radially disposed oxydiact pleuralia project. The parenchyma contains discohexasters with eight or more

rays, which break up at their extremities into a brush-like tuft of terminals, and also small discohexasters, in which numerous terminals arise from the disc-shaped expansion of the principal rays. The dermal and gastral skeletons contain rough tetracts and pentacts. Japan.

Genus 5. *Bathydorus*, n. gen.

Sack- or wine-skin-like forms with loose walls, and thin (always ?) oscular margin provided with a cuff-like marginal fringe of spicules. The parenchyma contains, besides large hexacts and diacts, also oxyhexasters, and in some species discohexasters. In the dermal skeleton, besides the smooth hypodermal oxypentacts, numerous rough autodermal oxytetracts occur, and in some also autodermal diacts and even monacts. The gastral skeleton contains exclusively rough oxyhexacts.

Species 1. *Bathydorus fimbriatus*, n. sp.

A large smooth wine-skin-like form, in which the thin superior oscular margin is equipped with a wreath of oxydiact marginalia. The parenchyma contains, besides the principal diacts, oxyhexasters with long frequently S-shaped terminal rays. The autodermalia are rough cruciate oxytetracts; the gastralia are rough or spinose oxyhexacts. North Pacific, 2300 to 2900 fathoms.

Species 2. *Bathydorus stellatus*, n. sp.

From the external surface of the sack-shaped body, isolated oxydiacts project radially or obliquely outwards. The parenchyma contains numerous stars. The dermal and gastral skeletons resemble those of *Bathydorus fimbriatus*. Messier Channel, Patagonia, 140 fathoms.

Species 3. *Bathydorus spinosus*, n. sp.

Externally like *Bathydorus stellatus*. The oscular margin bears a wreath of spicules. The parenchyma contains oxyhexasters with long, somewhat wavy terminal rays. The autodermalia are rough oxytetracts, the gastralia oxyhexacts of varying size, sometimes rough, sometimes smooth. Penguin Island, 1600 fathoms.

Species 4. *Bathydorus baculifer*, n. sp.

Externally like *Bathydorus spinosus*. The parenchyma contains oxyhexasters and discohexasters. The dermal skeleton includes numerous rough autodermal diacts and monacts. In the middle of the South Pacific, 2335 fathoms.

Genus 6. *Rhabdocalyptus*, n. gen.

Moderately thin-walled cups with smooth external surface, and sharp-edged smooth margin to the wide oscular aperture. The inner surface exhibits holes of variable size—the apertures of the efferent canals. The principal parenchymalia are diacts of variable length. The parenchyma also contains discohexasters and oxyhexasters, and further eight-rayed rosettes with disc-bearing terminal rays on each of the medium-sized principals. The dermal membrane contains rough diacts either exclusively, or plus rough pentacts, tetracts, and monacts. The gastralia are rough oxyhexacts.

Species 1. *Rhabdocalyptus mollis*, n. sp.

A funnel-shaped, somewhat compressed cup with a short round stalk. The parenchyma contains small oxyhexacts in which the rays near the point of intersection are beset with inward directed spines. The rays are frequently curved and may be also reduced to four or two. The dermal membrane contains only rough diacts, and the gastral membrane only rough hexacts. Japan, 100–200 fathoms.

Species 2. *Rhabdocalyptus rœperi*, n. sp.

A sack-shaped cup, which is directly attached by its thick blind end. The parenchyma contains oxyhexasters with short principal rays and long undulating terminals. The dermal membrane contains rough pentacts, tetracts, diacts, and monacts. In the gastral and canalicular membrane there are weakly developed hexacts with tubercled or uniformly rough rays. South of Puerto Bueno, Patagonia, 400 fathoms.

Genus 7. *Crateromorpha*, Gray.

Stalked goblets with smooth external surface. On the gastral internal surface the efferent canals open directly into the gastral space, with round apertures of variable width. In the loose parenchyma, besides medium-sized hexacts and diacts oxyhexasters and discohexasters occur of variable form and size. The dermal membrane contains rough tetracts, pentacts, and sometimes also diacts, all three with club-shaped thickened ends. The gastral membrane contains rough pentacts.

Species 1. *Crateromorpha meyeri*, Gray.

A tulip-shaped cup, varying in size from a hen's to a goose's egg, and seated on a stalk of the length and thickness of one's little finger. On the oscular margin of the wide

gastral cavity there is a thin skin-fringe, 4 mm. in height. The parenchyma contains oxyhexasters with very short principals, and small discohexasters with many terminal rays. The dermal membrane contains, besides many pentacts, some tetracts. The inner surface of the efferent canals bears small rough oxyhexacts. The stalk is penetrated by canals. Zebu (Philippines), 95 fathoms; Japan.

Species 2. *Crateromorpha thierfelderi*, n. sp.

The hollow stalk, somewhat thicker than a goose-quill, passes gradually into a spindle-shaped cup, about the size of a hen's egg. The sharp oscular margin bears a thin dermal fringe. The outer surface of body and stalk is smooth; the inner surface exhibits the round variously-sized apertures of the efferent canals. The parenchyma contains oxyhexasters with somewhat externally curved terminal rays and small discohexasters. The dermal membrane contains rough tetracts and pentacts. Little Ki Island, 140 fathoms.

Species 3. *Crateromorpha murrayi*, n. sp.

A broad, superiorly campanulate cup larger than a man's fist, with a strong hollow stalk as thick as a thumb, and a sharp smooth oscular margin. The external surface is smooth; the internal surface exhibits round, variously sized apertures of the efferent canals. The parenchyma contains oxyhexasters with terminal rays somewhat curved at their ends. The dermal membrane contains small rough pentacts, tetracts, and less frequently diacts. The gastral membrane contains rough pentacts and tetracts. Little Ki Island, 140 fathoms.

Species 4. *Crateromorpha tumida*, n. sp.

The superiorly expanded stalk bears an irregularly ridged cup, somewhat larger than a fist. The superior, irregularly frilled, smooth, and somewhat sharp oscular margin projects straight upwards. The parenchyma contains oxyhexasters in which the long terminal rays are frequently curved at their extremities, and also discohexasters with rather numerous long terminals. The dermal membrane contains tetracts, and less frequently diacts, or even triacts. Banda Islands, 360 fathoms.

Genus 8. *Aulochone*, n. gen.

Cylindrical or spherical cup-like forms, borne on long tubular stalks. The oscular margin is folded backwards in such a way that a portion of the originally internal gastral

wall has become the external wall of the body, while the other internal portion of the gastral wall, which exhibits the roundish excurrent apertures of the efferent canals, is continued directly into the internal surface of the stalk lumen. The fine quadratic lattice-work of the dermal membrane lies on the inferior surface of the body. The parenchyma contains between long diacts numerous oxyhexasters, and, though less abundantly, also discohexasters. The dermal and gastral membranes exhibit a predominant or exclusive occurrence of small rough pentacts.

Species 1. *Aulochone cylindrica*, n. sp.

The cylindrical body, about the size of a child's fist, exhibits a funnel-shaped gastral cavity, and on the superior everted margin of the gastral membrane a somewhat sharp, undulating edge, while the lower or true oscular margin is more uniformly sharp and smooth. Among the numerous oxyhexasters of the parenchyma, much dwarfed forms occur. The discohexasters have numerous terminal rays arranged in a tuft on each principal. Between the rough pentacts of the dermal membrane there are sometimes also similarly formed tetracts. The gastral membrane contains exclusively rough pentacts. North-east of the Kermadec Islands, 600 fathoms.

Species 2. *Aulochone lilium*, n. sp.

The lateral surface of the hemispherical, rather than cylindrical body is somewhat puffed out, and passes not so much by a superior edge as by an arched marginal region into the funnel-shaped wall of the gastral cavity, while towards the dermal inferior surface it is very distinctly defined by a sharp-edged oscular margin. The parenchyma contains, besides numerous oxyhexasters with long rays, also discohexasters with S-shaped terminals arranged in calyx-like fashion. Both dermal and gastral membranes contain rough pentacts. Meangis Islands, north-east of Celebes, 500 fathoms.

Genus 9. *Caulocalyx*, n. gen.

With the single species, *Caulocalyx tener*, n. sp.

The simple cup-shaped body is gradually contracted inferiorly into a solid narrow stalk. From the smooth lateral wall long isolated oxydiacts project radially. Between the long diacts of the parenchyma discohexasters of variable strength project, in which the long terminal rays are gradually thickened towards the outer end, and terminate in a marginally toothed hemispherical transverse disc. The dermal skeleton contains oxypentacts with spines on the four tangential rays. West of Tristan da Cunha, 2025 fathoms.

Genus 10. *Aulocalyx*, n. gen.

With the single species *Aulocalyx irregularis*, n. sp.

A thin-walled cup, much folded, extended into lateral diverticula, and also continued into short laterally projecting tubes. The cup is fixed by a firm irregular base. The connected framework of beams consists of much curved hexacts, partly united by synapticula, partly soldered together. The parenchyma contains loose discohexasters with short or with medium-sized principal rays, bearing S-shaped terminals disposed in perianth-like fashion. Under the skin there are large hexasters in which each of the short principal rays bears six long diverging terminals, which gradually increase in thickness towards the round outer end, and are beset all round with backward bent pointed hooks. The dermalia and gastralia are rough medium-sized oxypentacts. Marion Islands, south-east of the Cape of Good Hope, 310 fathoms; between Marion and the Crozet Islands, 600 fathoms.

Genus 11. *Euryplegma*, n. gen.

With the single species *Euryplegma auriculare*, n. sp.

Cup- or ear-shaped plate, 3 to 5 mm. in thickness, with smooth convex outer surface, penetrated, however, by numerous longitudinally disposed, oval incurrent apertures, and a concave internal surface exhibiting numerous longitudinal ridges and papilla-like bosses 3 to 4 mm. in breadth. The excurrent apertures, 1 to 2 mm. in width, are found between the longitudinal ridges and on the summit of each protuberance. The beams of the very irregular dictyonal framework, which exhibits numerous ladder-like structures formed by transverse synapticula, are beset with small scattered pointed tubercles, and exhibit *no* thickening of the nodes of intersection. The loose parenchymal spicules are small simple rough oxyhexacts and discohexasters of various kinds. Some of the latter bear three to five somewhat markedly divergent terminals, while in others the moderately short principals exhibit three to ten long S-shaped rays, united in a slender calycine arrangement.

The dermal and gastral skeletons consist exclusively of oxypentacts, which bear small tubercles at the ends of the sharpened rays, but are otherwise smooth. Off Raoul Islands, north-east of New Zealand, 630 fathoms.

Tribe II. AMPHIDISCOPHORA, F. E. S.

Amphidiscs are always present in the limiting membranes. The parenchyma contains no hexasters whatever. A basal tuft of fibres is always present, anchoring the cup- or

club-shaped sponge in the mud. The chambers are not exactly thimble-shaped, nor sharply marked off from one another, but form irregular diverticula of the membrana reticularis.

Family Hyalonematidæ, Gray.

Both dermal and gastral membranes contain numerous pentact pinuli.

Subfamily 1. Hyalonematinæ, F. E. S.

The compressed usually cup- or goblet-shaped body bears on the upper surface a more or less sharply contoured round excurrent (oscular) region, and is only exceptionally split laterally.

Genus 1. *Hyalonema*, Gray.

At the lower pole of the funnel-shaped or more spherical body, there is a long, narrow, sharply defined root-tuft, in which the spicules are at their lower end equipped with a four-toothed anchor structure. No uncinates. The slender marginalia are superiorly pointed diacts with toothed distal ray.

Subgenus 1. *Hyalonema*, s. str.

The superior aperture of the gastral cavity is covered by a sieve network which extends from the annular rim with its cuff-like fringe of fine marginalia, either flatly over the whole gastral aperture, or sunk into a funnel-shaped depression.

Species 1. *Hyalonema sieboldii*, Gray.

The almost cylindrical, inferiorly rounded, superiorly truncate body shows at its inferior pole a twisted tuft of long spicules, almost as thick as a little finger. The terminal sieve-plate exhibits a cruciate zone of imperforate skin, lying above the four crossed radial septa, and bears in the middle a central cone.

The upper portion of the root-tuft is surrounded by an encrustation of *Palythoa fatua*, Max Schultze, and other commensal Anthozoa are seated on the external skin. The parenchyma contains small oxyhexacts with straight, and others with curved toothed rays. The larger amphidiscs have broad arched umbels with eight rather broad paddle-shaped rays. Japan.

Species 2. *Hyalonema gracile*, n. sp.

The inverted pear-shaped, superiorly truncate, inferiorly pointed body, is hardly as large as a plum, and forms a slender untwisted basal tuft without a *Palythoa* encrustation. The delicate terminal sieve-plate extends freely over the gastral cavity, which exhibits internally a central columella and four cruciately disposed radial septa. The parenchyma contains small oxyhexacts with straight, or curved smooth rays. The large amphidiscs have moderately long arched terminal umbels with eight rather broad lancet-shaped rays. Philippines, 2225 fathoms.

Species 3. *Hyalonema divergens*, n. sp.

The body has the form of an inverted, not belly-shaped, bell with the maximum breadth at the superior, transversely truncated end. Over the flat gastral cavity with its free central columellar cone, a delicate latticed network extends transversely. The basal, somewhat narrowed end gives off a bundle of rather straight and thick spicules, forming a basal tuft without a *Palythoa* encrustation. The parenchyma contains small oxyhexacts, some with straight, and others with curved smooth rays. The large amphidiscs have terminal umbels with somewhat transversely truncated extremity. The moderately long, but not very broad umbel-rays, with parallel margins, are almost straight and diverge rather markedly. Mid-Pacific, east of Maldon Island, 2425 fathoms.

Species 4. *Hyalonema toxeres*, Wyville Thomson.

The spherical body, which is puffed out in the young forms, bears on its pointed inferior end a brush-like diverging basal tuft with encrusting *Palythoa* on its upper portion. Free terminal sieve-plate. The parenchyma contains small oxyhexacts, some with straight, and others with curved rays, of which the latter are beset with barbs. Large, thick, somewhat curved diacts also occur. Large amphidiscs like those of *Hyalonema sieboldii*. Near St. Thomas, West Indies, 390 fathoms.

Species 5. *Hyalonema kentii*, O. Schmidt.

Funnel-shaped body, with the sieve-plate intruding into the gastral cavity. The parenchyma contains small weakly developed oxyhexacts, some with straight, others with curved, almost smooth rays. Large amphidiscs with broad hemispherical terminal umbels, in which the eight rays are broad lancet-shaped plates. West Indies, 300 to 1500 fathoms.

Species 6. *Hyalonema poculum*, n. sp.

Funnel-shaped. Sieve-plate bent inwards. The small parenchymal oxyhexacts have all straight and somewhat rough rays. The large amphidiscs have hemispherical terminal umbels and narrow pointed rays. Near the Island of Juan Fernandez, west of Valparaiso, 1375 fathoms.

Species 7. *Hyalonema conus*, n. sp.

Conical form. The sieve-plate somewhat flatly stretched. Parenchymal oxyhexacts with straight smooth rays. Large amphidiscs with flat, broad, terminal umbels with eight broad paddle-shaped rays. South of Australia, 1800 fathoms.

Subgenus. 2. *Stylocalyx*, n. subgen.

The aperture of the gastral cavity is not covered by a common sieve-plate, but is quite open. The gastral space is cruciately divided into four chambers by radial septa.

Species 1. *Stylocalyx thomsonii*, Marshall.

The body is approximately spindle-shaped. From the open aperture of the gastral space the columellar cone projects for some distance as a long and narrow smooth conical elevation, on which the four broad radial septa of the gastral space are extended upwards. The somewhat twisted tuft of basal spicules is superiorly covered by a *Palythoa* encrustation. The parenchyma contains small oxyhexacts with straight *smooth* rays. North of Shetland Islands, 550 fathoms.

Species 2. *Stylocalyx apertus*, n. sp.

From the lower pole of the spherical or bulging body a slightly-twisted basal tuft (5 mm. thick) projects, covered on its superior portion by a *Palythoa* crust. The apex of the central cone does not quite reach the level of the oscular margin. The rays of the small parenchymal oxyhexacts are curved and beset with barbs. The large amphidiscs have hemispherically arched terminal umbels with six broad, lancet-shaped radiating rays. The dermal and gastral pinuli have short toothed basal rays, and a slightly spinose radial. Sagami Bay, Japan, 345 fathoms.

Species 3. *Stylocalyx depressus*, n. sp.

The body is of a flat cake-shape or approximately spherical, and attains the size of a man's fist. The oscular aperture is comparatively narrow, and surrounded by a smooth-

margined membranous collar. The root-tuft bears no *Palythoa* encrustation, and consists of tolerably straight spicules. The central cone rises to the opening of the gastral cavity, which is traversed by four cruciate radial septa. The small oxyhexacts of the parenchyma are almost wholly provided with curved rays, which bear small barbs. Between these there are a few oxyhexacts with small barbs on the *straight* rays. The larger amphidiscs bear somewhat long, lacerate, campanulate terminal umbels, with eight slender pointed rays. The dermal pinuli have short, thick, rough basal rays, and a radial beset with long lateral spines. The gastral and canalicular pinuli have long rough basal rays, and a weakly developed radial with short thin lateral spines. North of Mellish Islands, Mid-North Pacific, 2050 fathoms.

Species 4. *Stylocalyx claviger*, n. sp.

The oscular margin of the oval body is sharp. The small parenchymal hexacts have delicate, smooth, usually quite straight rays. The large amphidiscs have broad, or somewhat highly arched terminal umbels, with eight broad paddle-shaped rays. The dermal pinuli are compressed, with bushy superiorly somewhat truncated radial ray. The gastral pinuli, on the other hand, have a long spindle-shaped solid radial ray, which is beset only with short teeth and scales. Near the Penguin Islands, 1600 fathoms.

Species 5. *Stylocalyx globus*, n. sp.

The spherical body bears at the basal pole a slender root-tuft of straight needles, without any *Palythoa* encrustation, while the superior pole exhibits a comparatively small, circular, sharp-edged oscular aperture without a fringe of spicules. From the free central cone four cruciate sharp-edged radial septa extend. The small parenchymal oxyhexacts have smooth, slender, straight rays. The larger amphidiscs have broad terminally truncate, tolerably short, terminal umbels, in which eight straight paddle-shaped rays diverge markedly outwards. The dermal pinuli have long, firm, roughened basal rays, and a moderately short bushy radial ray, in which the strongly developed axial portion bears long bent lateral spines, and ends in a conical swelling. The gastral pinuli have also moderately long and rough basal rays, but the radial which runs to a thin point bears short curved lateral spines. Near the Banda Islands, 360 fathoms.

Species 6. *Stylocalyx elegans*, n. sp.

The approximately spherical, but inferiorly conical body bears in the middle of the obliquely truncated upper surface an irregularly contoured oscular aperture, above which

a slender pointed central cone distinctly projects. The inferior pole bears a slender basal tuft of a few long gently curved spicules. The parenchyma contains many small oxyhexacts with smooth curved rays. The larger amphidiscs have lacerate and bell-shaped terminal umbels, with eight somewhat long rays, the pointed extremities of which extend almost to the middle of the amphidiscs. The dermal pinuli have somewhat short rough basal rays, and a long slender radial, running out to a thin point. South-east of Christmas Island, Mid-Pacific, 2425 fathoms.

Species 7. *Stylocalyx tener*, n. sp.

The oval or pear-shaped body exhibits a flat conical narrowed basis, giving off a narrow much twisted basal tuft of long thin spicules. The parenchyma contains numerous small oxyhexacts with smooth curved rays. The large amphidiscs are approximately spherical, with hemispherical terminal umbels of eight to twelve paddle-shaped rays, alternating with those of the other side and almost reaching them. The dermal pinuli have a long, slender, pointed and short-toothed terminal ray. South Pacific, 2550 fathoms.

To these there have to be added some species of *Hyalonema* which, owing to the insufficient preservation of the upper portion, or to inadequate description, cannot yet be referred to either of the above subgenera :—

Species 1. *Hyalonema lusitanicum*, Barboza du Bocage.

The long and strong spirally-twisted root-tuft is surrounded by a large *Palythoa* crust. The parenchyma contains small oxyhexacts with straight, or with curved smooth rays. The dermal pinuli exhibit four short basal rays and a somewhat long distal with moderately long lateral spines. The large amphidiscs are elongated and slender. Their deep bell-shaped terminal umbels have eight slender blunt rays. Near Setubal, Portugal.

Species 2. *Hyalonema cebuense*, Higgin.

The body has the form of a sculptor's mallet with the broad portion upwards. The basal tuft is thicker than a goose-quill, and is spirally twisted. The small parenchymal oxyhexacts have thin straight rays, which are curved outwards at their outer ends and bear lateral spines. The dermal pinuli are somewhat small and slender. The large amphidiscs are narrow, with deep bell-shaped umbels, in which the eight arms are slender. The parenchyma contains slender oxydiacts with teeth which are directed towards the centre. Zebu, Philippines.

Species 3. *Hyalonema tenue*, n. sp.

With narrow oval oscular aperture. The parenchyma contains small weakly developed oxyhexacts with smooth curved rays, and also somewhat larger forms with thin straight smooth rays. The large amphidiscs have campanulate terminal umbels with twelve to thirteen lancet-shaped rays. The dermal pinuli have somewhat long smooth basal rays, and a long, very thin radial. East of the mouth of the Rio de la Plata, 1900 fathoms.

Species 4. *Hyalonema robustum*, n. sp.

The parenchyma contains small oxyhexacts with smooth or slightly roughened curved rays. Besides these somewhat larger oxyhexacts occur with spinose straight rays. There is a characteristic occurrence of unusually large, approximately spherical amphidiscs, in which the hemispherical terminal umbels almost, or actually meet one another in the middle. They consist of eight, or less frequently as many as twelve broad paddle-shaped rays. The dermal pinuli have short, thick, rough, basal rays, and a long club-shaped, but at the same time pointed radial ray with moderately short lateral spines. West of the North Pacific, 2300 fathoms.

Genus 2. *Pheronema*, Leidy.

The basal terminal surface of the round, goblet- or cup-shaped, thick-walled body bears a broad root-tuft, not always sharply marked off. The lateral surface of the body also bears projecting tufts of spicules. The circular oscular margin is surrounded (with the probable exception of one species) by a cuff-like freely projecting collar. The parenchyma of the body contains uncinates. Each spicule of the root-tuft bears on its lower end a bidentate anchor. The marginalia and pleuralia end externally in a club-shaped swelling.

Species 1. *Pheronema annæ*, Leidy.

An egg-shaped body which is somewhat truncated both at its superior narrower and inferior broader pole. The gastral cavity is cylindrical, about half the length of the body, and with a flat floor. The broad basal tuft consists of numerous individual tufts about half the length of the body. Slender tufts of spicules project radially in irregular distribution from the lateral surface of the body. At the somewhat rounded oscular margin there seems to be no special wreath of spicules. The parenchyma contains small oxyhexacts sparsely beset with lateral spines. The large amphidiscs have campanulate terminal umbels with eight broad lancet-shaped rays, and a thick knobbed axial beam.

The dermal pinuli have four tolerably long, smooth and gradually pointed basal rays, and a moderately long distal which bears strongly developed upward bent spines. Santa Cruz, West Indies, 180 to 248 fathoms.

Species 2. *Pheronema carpenteri* (Wyville Thomson).

The body has a somewhat broad ellipsoidal form, slightly truncated at the upper and lower pole, of which the latter bears the broad basal root-tuft as long as the body, while the superior pole is surrounded by the cuff-like fringe of spicules round the osculum. The radial tufts projecting in irregular distribution from the lateral surface of the body form an annular zone for a finger's breadth below the oscular margin. The parenchyma contains long and short uncinates. The amphidiscs have hemispherical terminal umbels, each with eight moderately broad paddle-shaped rays. The dermal pinuli have long, smooth, pointed basal rays, and a moderately long, somewhat bushy radial. North of Scotland, 530 to 1600 fathoms.

Species 3. *Pheronema grayi*, Sav. Kent.

The body has the form of a bullfinch nest, with broad gastral cavity, occupying about two-thirds of a sphere, and bearing a long beard-like basal tuft. The prostalia lateralia are almost uniformly distributed over the whole outer surface, but form besides, as in *Pheronema carpenteri*, a thick zone measuring a finger's breadth across below the oscular cuff. Otherwise the forms of spicules agree essentially with the above species. Portugal.

Species 4. *Pheronema hemisphæricum* (Gray).

Body urn-shaped, with a concave indentation (annular groove) both above and below a gentle median swelling beset with tufts of spicules. The spicules of the broad basal tuft project downwards as far as the body is long, and form a broad annular zone round a central free portion. The parenchyma contains small oxyhexacts, in which the rays bear raised lateral spines. The dermal pinuli have rough basal rays directed somewhat obliquely downwards, and a short slightly bushy radial. The gastral pinuli, on the other hand, have a long, slender radial ray. Zebu, Philippines.

Species 5. *Pheronema globosum*, n. sp.

The body occupies three-fourths of a sphere the size of a man's fist, and bears on its superior truncated extremity the wide oscular aperture of the flat gastral cavity. The

somewhat sharp-edged oscular margin bears a wreath of pointed spicules. Numerous tufts of radially disposed spicules project from the lateral surface of the body. The basal tuft is formed of numerous separate tufts of spicules, which are interlaced at the outer ends. In the external skin a thick network with irregular stellate structures is recognisable. The parenchyma contains, besides medium-sized uncinates, very numerous smaller forms with curved lateral spines. The large amphidiscs have a rather thick axial rod and hemispherically arched terminal umbels with eight broad paddle-shaped rays. The dermal pinuli have four rough, substantial, somewhat downward bent basal rays, and a moderately long bushy radial. Near Little Ki Island, 140 fathoms.

Species 6. *Pheronema giganteum*, n. sp.

An ellipsoidal body as big as a man's head, with a round oscular opening measuring a hand's breadth across, and surrounded by cuff-like wreath of spicules. The smooth external surface bears small scattered tubercle-like elevations, from the apex of each of which a tuft of long radial pleuralia projects. These increase in length towards the lower end, and measure more than a hand's length in the root-tuft at the base. The parenchyma includes, besides strong oxypentacts probably originating from the dermal skeleton, small spinous oxyhexacts and uncinates of various length and with short barbs. The large amphidiscs have a slender axial rod and hemispherical umbels with eight narrow rays. The dermal pinuli have rough basal rays of medium length, and a somewhat long uniformly broad tufted radial. Near Little Ki Island, 140 fathoms.

Genus 3. *Poliopogon*, Wyville Thomson.

The body forms either a plump goblet or a thin ear-shaped involute plate. The lower end forms a broad basal tuft, while the upper bears a delicate fringe of spicules round the sharp-edged oscular margin. The smooth external *lateral surface bears no pleural prostalia.* The parenchyma includes, besides rough or spinose small oxyhexacts, uncinates, and in one species also small smooth oxydiacts in variable abundance and size. The two anchor teeth of the basalia stand approximately at right angles to the long almost smooth shaft. The marginalia are externally club-shaped.

Species 1. *Poliopogon amadou*, Wyville Thomson.

An ear-shaped semi-involute thick plate with sharpened oscular margin, bearing a short and slender fringe of spicules. A fine square-meshed latticework is borne both on the convex outer dermal, and concave inner gastral surface. The parenchyma contains spinose oxyhexacts and numerous medium-sized uncinates. The larger amphidiscs have

somewhat conical, superiorly truncate terminal umbels with eight somewhat broad paddle-shaped rays. The dermal and gastral pinuli have moderately long toothed basal rays, bent in figure 8 fashion, and an elongated somewhat bushy but pointed distal. South-west of Canary Islands, 1525 fathoms.

Species 2. *Poliopogon gigas*, n. sp.

A very large, thick-walled, plump goblet, with a spacious gastral cavity more than a span wide, and opening by a circular osculum. Besides the parenchymal spicules mentioned in *Poliopogon amadou*, there are here small smooth spindle-shaped oxydiacts. The large amphidiscs resemble in form those of *Poliopogon amadou*, but have somewhat longer terminal umbels. In the pinuli the radial ray is shorter and less thickly spinose than in the otherwise very similar pinuli of *Poliopogon amadou*. Between the Raoul and Macaulay Islands, north of New Zealand, 630 fathoms.

Subfamily 2. Semperellinæ.

With the single genus *Semperella*, Gray.

With the single species *Semperella schultzei*, Gray.

The elongated club-shaped body bears at its base a brush-like root-tuft, but neither a simple round oscular aperture at its superior, gently conical end, nor a simple internal gastral cavity within. It is traversed by a connected system of thin-walled tubes, as thick as a little finger, associated with an axial main tube. Between these an approximately equal set of connected interspaces are left. While the lumen of the connected (efferent) tubes opens on the four to six, rounded off and irregular, longitudinal sides, and on the superior conical extremity of the club-shaped body by a sieve-shaped covering with comparatively wide meshes, the interjacent (afferent) canal system is covered on the flat sides of the body by a fine-meshed quadratic framework. The skeletal spicules resemble, for the most part, those of *Poliopogon amadou*. The long uncinates have, however, more strongly developed and somewhat curved spines. Besides the long spinose oxyhexasters, numerous reduced forms of the same occur, down to long spiny oxydiacts, and more rarely small uncinates with short spines and conically pointed extremities. The dermal pinuli have tolerably short, for the most part 8-shaped basal rays, and a short, strongly developed, and pointed distal with strong prominent lateral spines. The pinuli which occur on the dermal sieve-work of the excurrent region are, on the other hand, long and slender, with somewhat short, upward bent lateral spines.

The abundant and large amphidiscs, which occur especially in the dermal sieve-work of the excurrent region, have a strongly developed and knotted axial rod, with eight broad paddle-shaped terminals, somewhat conical, terminally truncated, short principal rays.

The boundary between excurrent and incurrent regions is marked by projecting toothed oxydiacts which run to a point or are slightly club-shaped. Zebu, Philippines; Little Ki Island, 140 fathoms.

Suborder II. DICTYONINA, Zittel.

Hexactinellida in which the large parenchymal hexacts are from the first more or less regularly united as dictyonalia in a firmly connected framework.

Tribe I. UNCINATARIA, F. E. S.

With uncinates.

Subtribe I. **Clavularia,** F. E. S.

Besides the pentact hypodermalia and hypogastralia there are groups of radially-disposed clavulæ.

Family I. FARREIDÆ, F. E. S.

In the youngest (most external) portions of the tubes the dictyonal framework consists solely of a single-layered network with square meshes, in which the nodes of intersection bear on either side a conical boss projecting at right angles.

Genus 1. *Farrea*, Bowerbank.

The stock, which is firmly attached by an expanded base, consists of a dichotomously branched tube tending to form anastomoses, or of a simple funnel-shaped cup. Beside each of the medium-sized hypodermal and hypogastral pentacts, there is a group of radially disposed clavulæ.

Species 1. *Farrea occa* (Bowerbank), Carter.

Richly ramified dichotomous and anastomosing tubes, which are gradually widened superiorly till they become as thick as a glove-finger. The parenchyma contains numerous slender oxyhexasters with long cylindrical principal rays, each with three to four short, markedly divergent terminals. The dermal clavulæ exhibit on their distal end, above a terminal swelling, an externally convex marginally toothed transverse disc, or else form transitions towards a simple club type, with ovoid or citron-shaped terminal

knob, frequently with a transverse ring of teeth. The gastral clavulæ are almost always well-developed, verticillate forms, with convex marginally toothed terminal disc and a very variable number of teeth. Sagami Bay, Japan, 100 to 200 fathoms; west of Manila, 700 fathoms.

Species 2. *Farrea sollasii*, n. sp.

The parenchyma contains discohexasters with short principal rays and long delicate gently diverging terminals. They otherwise closely resemble *Farrea occa*. Sagami Bay, Japan, 100 to 200 fathoms.

Species 3. *Farrea vosmaeri*, n. sp.

The parenchyma contains strongly developed oxyhexasters with long and strong principal rays, and four short, markedly divergent, usually somewhat outward bent terminals. Discohexasters also occur with short principal rays and weakly developed long terminals, as also discohexasters with somewhat strongly developed, long principals, each with four short S-shaped terminals disposed in a cup-like form, and bearing terminal knobs. Sagami Bay, Japan, 100 to 200 fathoms.

Species 4. *Farrea clavigera*, n. sp.

A straight main tube rising at right angles gives off transverse and terminal, branched and anastomosing secondary tubes. The parenchyma contains oxyhexasters with long principal rays, each bearing four markedly diverging terminals. The dermal clavulæ always exhibit a club-shaped distal end, which is sometimes elongated and quite smooth, in other cases compressed and weakly developed, and provided with a simple or double transverse circle of hooks. The gastral clavulæ all exhibit four cruciately disposed, much recurved anchor teeth. Near the Banda Islands, 200 to 360 fathoms.

Subtribe II. **Scopularia**, F. E. S.

Besides the hypodermal and hypogastral pentacts radially disposed scopulæ occur.

Family I. Euretidæ, F. E. S.

Branched and manifoldly anastomosing tubes, which either form an irregular framework or the lateral wall of a cup. The dictyonal framework in the tubular wall always

consists of several layers, so that the outermost ends of the tubes never exhibit (as in *Farrea*) a single-layered network of beams.

Genus 1. *Eurete* (Semper), Carter.

A richly anastomosing framework of approximately uniform tubes, attached at several places to the substratum, and exhibiting numerous oscular apertures.

Species 1. *Eurete semperi*, n. sp.

The oscular terminal apertures of the tubes, which are almost as thick as a little finger, always occur on the free, transversely truncated ends of the numerous stumps. The somewhat irregular dictyonal framework consists of strong beams irregularly beset with few little spines. The beams are united in spherically thickened nodes of intersection, which are richly beset with small tubercles. The parenchyma contains, besides the uncinates and simple oxyhexacts, numerous small discohexasters with short principal rays and moderately long terminals. The dermal scopulæ bear on the end of a small conical expansion, four (less frequently five or six) cruciately disposed *smooth, spindle-shaped* prongs. The gastral scopulæ have four cruciately disposed prongs, in which the thin outward bent stalk ends in a club-shaped swelling, which is covered on to the smooth apex with small barbs. Near the Little Ki Island, 140 fathoms.

Species 2. *Eurete schmidtii*, n. sp.

A somewhat narrow-meshed system of anastomosing tubes which measure about 5 mm. in width. The meshes of the dictyonal framework are predominantly square, and consist of smooth or slightly spinose beams with slightly thickened moderately spinose nodes of intersection. The parenchyma contains, besides the variously disposed uncinates, small rough oxyhexacts and oxyhexasters with short principal rays, each with two terminals. Most of the dermal scopulæ bear on the distal end of the inferiorly pointed smooth stalk, a knotted swelling, with two to four smooth, pointed terminal prongs, while the others exhibit a thickening with four prongs with thin stalks and pear-shaped terminal knobs with lateral barbs. The gastral scopulæ belong exclusively to the latter type. Philippines, 102 fathoms; Japan.

Species 3. *Eurete farreopsis*, Carter.

The irregularly anastomosing system exhibits tubes 4 to 5 mm. in width, and somewhat wider intermediate spaces. The nodes of intersection of the predominantly square-

meshed dictyonal framework are somewhat thickened and slightly spinose. The parenchymalia contain, besides the uncinates, disposed at right angles to the bounding surfaces, and small rough oxyhexacts, small disco- and sphæro-hexasters, with four moderately long terminals on each of the short principal rays. Both the dermal and the gastral scopulæ exhibit a marked and sharp dislocation on their four to six terminal prongs, which are equipped with pear-shaped terminal knobs bearing lateral barbs. Near the Little Ki Island, 140 fathoms.

Species 4. *Eurete carteri*, n. sp.

Somewhat narrow-meshed anastomosing systems of tubes 3 to 10 mm. in width, which open externally by round or oval apertures not only terminally but also laterally. The somewhat irregular dictyonal framework exhibits spinose beams with but slightly thickened nodes of intersection, varying in different regions, but tolerably constant in the development of spines. The parenchyma contains, besides the radially disposed uncinates and numerous small oxyhexacts, irregularly scattered small *discohexasters* with short principal rays, and moderately long, *irregularly undulating terminals*, three of which usually occur on each principal. Both the dermal and gastral scopulæ have four to six straight or slightly curved, but never dislocated terminal prongs with barbed terminal knobs. Near the Little Ki Island, 140 fathoms; Sagami Bay, Japan, 150 fathoms.

Species 5. *Eurete marshalli*, n. sp.

A somewhat wide-meshed framework of tubes of varying width (3 to 8 mm.), with round terminal excurrent apertures. The dictyonal framework with its predominantly square meshes exhibits, as in *Eurete farreopsis*, Carter, somewhat thickened and spinose nodes of intersection. The parenchyma contains, besides the radial uncinates and small oxyhexacts, also *oxyhexasters* with short principal rays, each with three to five long terminals. The dermal and gastral scopulæ exhibit *no* dislocation of the four terminal prongs which end in club-shaped barb-beset extremities. Near the Little Ki Island, 140 fathoms.

Species 6. *Eurete bowerbankii*, n. sp.

The single fragment as yet known consists of a funnel-shaped expanded tubule 3 to 10 mm. in diameter, provided with lateral branches 5 mm. in breadth. The somewhat irregular dictyonal framework consists of slightly spinose beams without markedly thickened nodes of intersection. The parenchyma contains, besides the radial

uncinates and small oxyhexacts, *numerous oxyhexasters with strongly developed long* principal rays, each with four short, markedly diverging terminals. The dermal and gastral scopulæ exhibit straight, or slightly curved, but never dislocated prongs with barbed terminal knobs. Japan, 80 to 200 fathoms. Sagami Bay, Japan, 100 to 200 fathoms.

Genus 2. *Periphragella*, Marshall.

With the single known species *Periphragella elisæ*, Marshall.

A cup- or funnel-shaped form, about a hand's length in height, with a lateral wall formed of an irregularly anastomosing system of tubes. A somewhat solid basal portion about as thick as a finger forms an attaching expansion, and passes gradually into the parietal tubes, which measure at first 3 to 4 mm. in width, but become gradually wider upwards. These tubes arise from the folding of the primary plate-like funnel-wall, and are thus on the one hand in open communication with the large internal gastral cavity, and on the other by the round terminal aperture with the exterior. The beams of the tolerably regular, square or rectangularly meshed dictyonal framework are smooth or slightly spinose, and exhibit no markedly thickened nodes of intersection. The parenchyma contains, besides the usually, but not exclusively radially disposed uncinates and small oxyhexacts, *oxyhexasters* with rather short principal rays, each with two to four moderately long, externally curved terminals, and also *discohexasters,* with five or more medium-sized, thin, somewhat externally convex terminals on each of the strongly developed medium-sized principals. The dermal and gastral scopulæ exhibit a stalk with club-shaped swollen ends, while on the other end, turned towards the free bounding surface, there are four prongs with pear-shaped or spherical, barb-beset, terminal knobs. Many of the dermal scopulæ exhibit no thickening below the origin of their four gently outward-bent knobbed prongs. Moluccas; Japan, 80 to 200 fathoms.

Genus 3. *Lefroyella*, Wyville Thomson.

With the single species *Lefroyella decora*, Wyville Thomson.

In the compact skeletal framework of the (1 cm. thick) wall of the syringe-shaped body, there are radially disposed longitudinal plates 2 to 4 mm. in breadth, which project inwards, enclosing longitudinal furrows between them, while the external surface exhibits in the firm cortical layer numerous spirally or circularly disposed round apertures, 3 to 4 mm. in width, with projecting annular fringe. The beams forming the usually distinctly square meshes of the dictyonal framework, are in the neighbourhood of the free bounding surfaces of the tubes slightly spinose, but are otherwise smooth, only here and there exhibiting somewhat thickened nodes of intersection. Bermudas, 1075 fathoms.

Family II. MELITTIONIDÆ, Zittel.

Sponges in the form of a ramified tube or of a cup with lateral blind diverticula. The dictyonal framework forms very irregular meshes. The parietal skeleton is honey-comb-like, with tolerably *regular hexagonal*, radially disposed canals, arranged at right angles to the bounding surfaces. In each of these little canals the membrana reticularis, is continued in a funnel-shaped extension of the laterally disposed, glove-finger-like chambers, across the canalicular lumen. The free outer surface is covered with the dermal membrane, and the inner surface with the gastral. The gastral skeleton is without scopulæ.

Single Genus *Aphrocallistes*, Gray.

On the hexact dermalia the distal radial ray is more or less distinctly fir-tree-like with a lateral coating of spines. Besides these there are dermal scopulæ, in which the prongs are usually knobbed, more rarely pointed. The parenchyma contains irregular oxyhexasters, and in many cases also discohexasters.

Species 1. *Aphrocallistes bocagei*, Perceval Wright.

An elongated, almost tubular cup, a hand's length or more in height, with numerous glove-finger-like radial, and somewhat downward directed diverticula from the wall. The lumen of the cup is traversed at considerable intervals by several loose lattice-work septa, which correspond in their insertion on the sides to the lateral diverticula, and exhibit semicircular sections. The loose parenchymalia are represented by uncinates directed at right angles to the bounding surface, and also by hexasters of different kinds. Besides oxyhexasters with approximately equal principals and terminals, there are others in which the axis is considerably elongated, and in which the two strong, more or less long principal rays are divided at their extremities into four markedly divergent moderately long terminals, while the four rays representing the two other axes remain, as a rule, undivided. Small discohexasters occasionally occur. Corresponding to the dermal hexact pinuli, there are on the gastral surface autogastral diacts of variable length, which are more or less rough, especially on their rounded extremities. The dermal scopulæ possess, for the most part, four straight somewhat diverging prongs with pear-shaped terminal knobs bearing lateral barbs. Besides these there are dermal scopulæ with four pointed rough prongs, and others with four strikingly long, rough prongs equipped with small spherical knobs. Cape Verde Islands; Florida, 283 fathoms; English Channel, 700 fathoms; coasts of Spain and Portugal; Antilles Islands, 164 to 400 fathoms; Atlantic coast of France.

Species 2. *Aphrocallistes beatrix*, Gray.

In form resembling *Aphrocallistes bocagei*, Wright, but much smaller and more delicate. Besides the uncinates the parenchyma contains almost exclusively much elongated oxyhexasters, in which one (principal) axis possesses two long strong principal rays, occasionally with a few lateral spines, and dividing into four strongly developed, moderately long, and somewhat markedly divergent terminals, while the four other rays exhibit uniformly short, simply pointed rays without terminals. Malacca.

Species 3. *Aphrocallistes vastus*, n. sp.

A large cup, 40 cm. or more in height, and 30 cm. in breadth, rising from a compact knobbed basal portion growing on the substratum. The lateral diverticula of the wall are flat and pouch-like, and longitudinally disposed. The parenchyma contains besides long uncinates, most swollen near the outer end, numerous disco- or sphæro-hexasters with moderately long terminal rays of variable form and size. On the dermal hexact pinuli the free distal ray is broad and bushy. The dermal scopulæ usually bear only two or three straight, somewhat uniformly thick, terminally rough prongs without distinct terminal knob. The gastral membrane contains straight rough diacts, and occasionally monacts. Japan, 180 fathoms.

Species 4. *Aphrocallistes ramosus*, n. sp.

Dichotomously branched tubes, 4 to 10 mm. in diameter, attached by means of a compact basal plate. The branches open with round terminal apertures. The loose parenchymalia are represented not only by uncinates and by numerous small rough oxyhexacts, but also by oxy- and sphæro-hexasters elongated in the direction of the main axis, with principal rays of various length, and with moderately long terminals, usually developed only on the two principals of the long axis. The dermalia have a weakly developed distal ray, which is frequently either almost, or wholly without the lateral spines of the pinuli. The adjacent dermal scopulæ possess four straight, or slightly dislocated prongs with spiny terminal knobs. The gastral membrane contains diacts of various length, with rough and rounded ends. Japan, 80 to 200 fathoms; Phillippine Islands, 375 fathoms.

Family III. Coscinoporidæ, Zittel.

The smooth wall of the cup-, goblet-, or plate-like firmly fixed body is traversed by more or less elongated, funnel-shaped, *straight* canals, which open alternately on either

surface, covered only by the sieve-like bounding membrane, but end in a blind point at the other extremity. They thus always correspond approximately in length to the parietal thickness of the sponge.

Single Genus *Chonelasma*, n. gen.

The body consists of an upright plain or slightly curved plate about the size of a hand, and exhibiting an irregularly chambered smooth free margin, or of a funnel-shaped cup with lateral glove-finger-like parietal diverticula.

Species 1. *Chonelasma lamella*, n. sp.

The dictyonal framework enclosing rectangular meshes exhibits in its median region a loose structure with wider meshes than in the neighbourhood of the two bounding surfaces. The beams of the framework are usually beset with small pointed tubercles, and are connected without thickening of the nodes of intersection. The parenchyma includes, besides the uncinates and simple rough minute oxyhexacts, small rough discohexacts, oxyhexasters, and discohexasters with long terminal rays.

The dermalia and gastralia are strongly developed pentacts, in which the proximal or distal radial ray, as also the sides of the four tangentials turned towards the free surface, are richly beset with short spines. Besides these the dermal skeleton contains scopulæ, with four knobbed, straight prongs, which rise from a thick stalk-node. Kermadec Islands, 520 fathoms; west of Kerguelen Islands, 550 fathoms; Bermuda Islands, 1705 fathoms.

Species 2. *Chonelasma hamatum*, n. sp.

An upright, hand-shaped plate, 3 to 5 mm. in thickness, with a slightly undulating curvature, and with irregular roundish marginal contour. The dictyonal framework resembles that of *Chonelasma lamella*. The loose parenchymalia include, besides uncinates and numerous small rough oxyhexacts which tend to become soldered to the dictyonal framework, small discohexasters, some of which bear short principal rays with six to eight long, S-shaped terminals in perianth-like arrangement, while others possess long, rough, strongly developed principals, with short, S-shaped terminals. The dermal and gastral skeleton is formed of hexacts, in which the projecting radial ray is short and beset with inconspicuous spines. Besides these the dermal skeleton especially contains abundant scopulæ, some of which bear near the outer end of their stalk an annular swelling or four cruciately disposed bosses, in which an intersection of axial canals can be distinctly seen. Their four straight or slightly S-shaped prongs end either in a simple rounded off extremity, or in a minute knob-like thickening. Kermadec Islands, 520 fathoms.

Species 3. *Chonelasma dœderleinii*, n. sp.

A slightly undulating upright plate, with irregular rounded margin and somewhat thickened firmly attached basis. The dictyonal framework agrees essentially with that of *Chonelasma lamella*. The parenchyma contains, besides the uncinates, numerous large, delicate discohexasters, with short principal rays on each of which three or four long, thin, somewhat curved or undulating terminals are borne. The dermal and gastral skeletons consist of hexacts with bushy, freely projecting radial ray, and of scopulæ with four straight or slightly curved prongs, covered with short barbs, and ending either in simply rounded, or in small knob-like extremities. Japan, 80 to 200 fathoms.

Species 4. *Chonelasma calyx*, n. sp.

The body is cup-shaped, and over a hand's length in height. The dictyonal framework of the cup and of the radial glove-finger-like parietal diverticula consists of smooth or slightly spinose beams, and is slightly more irregular than that of *Chonelasma lamella*. The loose parenchymalia resemble those of the latter. In the dermal and gastral hexacts the freely projecting ray is somewhat compressed and clubbed, and is further beset with scale-like lateral teeth. The dermal and gastral scopulæ bear four to six straight or S-shaped prongs, beset with barbs, and either rounded off at the ends or with a club-shaped thickening. Japan, 80 to 200 fathoms.

Family IV. Tretodictyidæ, F. E. S.

Uncinataria with irregular afferent and efferent canals which penetrate the body-wall, not at right angles to the bounding surfaces, that is transversely, but obliquely or longitudinally, or even in curved course.

Genus 1. *Hexactinella*, Carter.

Cup- or tube-shaped forms, with canals which traverse the body-wall in an oblique longitudinal direction. The dictyonal framework contains reticulate plates, extending between parallel canalicular spaces in a longitudinal or radial fashion.

Species 1. *Hexactinella tubulosa*, n. sp.

Dichotomous and anastomosing tubes as thick as a little finger, rising from an encrusting base, and opening terminally by terminal apertures. The beams of the dictyonal framework are tubercled, and united without thickened nodes.

On the internal surface of the entire tubular skeleton there are longitudinal and radial plates alternating with grooves of equal breadth, while on the external surface the framework is flatly expanded. The loose parenchymalia are represented not only by very delicate uncinates and by numerous small rough oxyhexacts, but also by numerous oxyhexasters, with rather long strongly developed principal rays, each bearing two short moderately divergent terminals, besides simple medium-sized oxypentacts. The dermal skeleton contains scopulæ, with four approximately S-shaped rough prongs, which are at their extremities only slightly, or not at all swollen. The gastral skeleton contains numerous similar scopulæ, in which, however, the prongs are almost straight. There seem to be no pentacts in the gastral skeleton. Japan.

Species 2. *Hexactinella lata*, n. sp.

Ramified strong-walled tubes, in which the branches, more than a thumb's breadth in thickness, expand superiorly in funnel- or syringe-like fashion, and open by wide terminal apertures several centimetres in width. In the longitudinally disposed radial plates of the dictyonal framework, which alternate with grooves or canals of equal breadth, and are especially distinct on the external surface of the tubes, it may be seen that the dictyonal beams radiate from the inside and from below towards the exterior and superior surface. On the surface of the predominantly square-meshed framework there are minute tubercles, arranged for the most part in transverse rows. The loose parenchymal needles are represented by variously disposed weakly developed uncinates and numerous thin oxydiacts, also by small disco- or sphæro-hexacts, with cylindrical rays and terminal knobs, by oxyhexasters with long thin terminals, and, lastly, by sphærohexasters, with two to six simple straight or S-shaped terminals of medium length. In the moderately large dermal and gastral pentacts there is usually a more or less conspicuous rudiment of the sixth freely projecting radial ray. The dermal and gastral scopulæ have four knobbed, slightly divergent, rough prongs. Little Ki Island, 140 fathoms.

Species 3. *Hexactinella ventilabrum*, Carter.

A thick-walled cup, widely open above, and laterally somewhat compressed; borne by a broad firm base fixed to a solid substratum. The radial plates which extend between the predominantly longitudinal and oblique canals, traversing the wall often in curved courses, are more distinctly seen on the outer, than on the inner surface of the skeleton. The beams of the predominantly square-meshed framework are sparsely beset with minute irregularly distributed pointed tubercles. The loose parenchymalia are represented not only by a few uncinates with slightly developed barbs, but also by

oxyhexasters with short principal and long terminal rays, and by discohexasters. Of these the one set have moderately short principals and four to six long S-shaped terminals, while the others have long substantial principals and numerous short, somewhat convex, terminals. The dermal and gastral skeletons contain compact pentacts and four-pronged scopulæ, in which the rough, slightly curved, or almost straight rough prongs are equipped with slight terminal knobs. Besides the dermal pentacts, there are bundles of fine radially disposed oxydiacts projecting beyond the bounding surface. Japan.

Genus 2. *Cyrtaulon* (*Volvulina,* O. Schmidt), n. gen.

The variously shaped body is traversed by very irregular canals. The dictyonal framework forms an irregular feltwork of plates and strands. The parenchyma contains peculiar spicules, which may be regarded either as scopulæ with tuft-like or radially-disposed prongs bearing terminal discs, or better, as discohexasters with one *much elongated* and strongly developed principal ray, and five others always much shortened, and bearing tufts of terminal rays.

Species 1. *Cyrtaulon sigsbeei* (O. Schmidt).

A variously shaped, not unfrequently goblet-like form, in which the wall consists of an irregular feltwork, with cavities in which the apertures, both on the external and on the internal bounding surface, are covered with skin. The dictyonal framework itself consists of tubercled beams, in which here and there, especially near the surface of the sponge, the nodes of intersection are thickened and beset with wart-like prominences. The parenchyma contains uncinates with central thickening and modified scopulæ, or discohexaster forms with numerous thin prongs radiating out from the terminal node of the stalk, and bearing marginally toothed terminal discs. The dermal skeleton consists of medium-sized pentacts and hexacts, with typical scopulæ with knobbed prongs. Antille Islands, 100 to 300 fathoms.

Species 2. *Cyrtaulon solutus,* n. sp.

The only specimen as yet known is a cylindrical body within a cavity in a stone. The supporting framework is irregular with strands and plates. The dictyonal network exhibits small superficial tubercles, but no marked thickening of the nodes of intersection. The generically characteristic modifications of scopulæ or discohexasters, which occur in the parenchyma instead of the typical hexasters, exhibit on the knobbed and thickened end of the (otherwise pointed) stalk numerous thin radiating prongs or terminal rays, with small convex, marginally toothed terminal discs. Besides the pentacts of the dermal

skeleton there are scopulæ of the ordinary type, some of which bear four uniformly thick and barb-beset prongs without marked terminal swelling, while others exhibit six thin, smooth, slightly S-shaped prongs, with minute marginally-toothed terminal discs. In the gastral skeleton I found no pentacts, or indeed any hypogastralia, except simple scopulæ in their usual position, with four uniformly thick, barb-beset, unknobbed prongs. Little Ki Island, 140 fathoms.

Genus 3. *Fieldingia*, Sav. Kent.

With the single species, *Fieldingia lagettoides*, Sav. Kent.

An irregular round, sometimes almost spherical body, which is usually ensheathed in a thin parallel enveloping capsule, and traversed internally by an irregular framework of thin round strands, which exhibit numerous spherical compact knots, about 1 mm. in diameter, and occurring at distances of 2 to 3 mm. While the thin strands consist of a few long beams, beset with small, scattered and pointed tubercles, the spherical knots are formed of a thick framework of beams with a similar superficial appearance. Both the large, more or less elongated, and the short reticulate beams of the spherical knots have abundant small rough hexacts soldered on to them, usually at right angles. These doubtless serve to enlarge or thicken the dictyonal framework. The leaf-like enveloping capsule which surrounds the larger portion of the sponge, consists of pentacts bound together in plates by a narrow-meshed network of synapticula extending in the tangential direction. The parenchyma contains, besides long uncinates and simple small hexacts, oxydiacts with central nodes and sharpened extremities, oxyhexasters with very short, in some cases almost undeveloped principals, and long smooth terminals, and also discohexasters with short principals and rather long, slightly curved terminals. The dermal skeleton contains, besides the above-mentioned pentacts, scopulæ with four uniformly cylindrical, slightly divergent prongs, which are wholly covered with barbs, but exhibit no terminal swelling. Portugal, 500 fathoms; Little Ki Island, 140 fathoms.

Genus 4. *Sclerothamnus*, W. Marshall.

With the single species *Sclerothamnus clausii*, W. Marshall.

A shrub-like, dichotomously branched stock, with long, round, and terminal branches as thick as a little finger, and bearing spiral or annular pads a little finger's breadth across, and alternating with somewhat narrower grooves. The somewhat thick dictyonal framework supporting the body consists of beams which enclose predominantly rectangular meshes, and exhibit superficially numerous small, irregularly scattered, wart-like and pointed tubercles. They are united without nodal thickening. While the main strands of fibres in the axis of the branches lie longitudinally, *i.e.*, parallel to the axis, in the

external portion of the branches the strands bend out towards the lateral surface, and end below the skin, as is readily apparent on the macerated skeletons. The transverse beams between these principal strands are for the most part disposed at right angles. The afferent and efferent canals which penetrate the whole body are irregular roundish passages, running in various directions, but in general across the branches. Since the spiral or circular grooves on the branches are covered over with a fine square dermal lattice-work, while on the annular pads the outward bent skeletal strands and the associated efferent canals run at right angles to the lateral surface, it may be inferred that the afferent canals pass to the interior from the large subdermal spaces under the skin of the annular grooves, while the efferent canals open out on the pads. Isolated spicules in the parenchyma are represented not only by strongly developed uncinates, but by scopula-like spicules with a long, straight rough stalk, from which a few conical or finger-shaped elevations here and there project transversely, and with four markedly diverging, uniformly thick, rough unknobbed prongs rising from the thick extremity. The dermal skeleton contains hypodermal sword-shaped oxyhexacts, with a floricome-like sphærohexaster on the short radial ray. The principal rays of the latter are moderately short, and bear six long terminals, disposed in perianth fashion, diverging slightly outwards, gradually thickened, and ending in a spherical knob. Besides these hypodermal hexacts there are scopulæ with rough stalks narrowed inferiorly, and bearing at the thick distal end four slightly S-shaped or straight, uniformly thick prongs, which are wholly beset with small barbs, and end in slight, knob-like, terminal swellings. Philippines; Timor, 360 fathoms.

Tribe II. INERMIA, F. E. S.

Dictyonina *without* uncinates or scopulæ.

Single Family MÆANDROSPONGIDÆ, Zittel.

The body consists of a connected system of labyrinthine anastomosing tubes of approximately uniform width, between which there is a connected interstitial system of interspaces. The water passes by the latter into the interior, penetrates the walls of the tubes, and passes by the tubes either into the gastral cavity or directly to the exterior.

Genus 1. *Dactylocalyx*, Stutchbury.

The thick wall of the plump and generally cup-shaped body exhibits both on the outer and on the inner surface broad irregular pads, and interjacent clefts or grooves. The external swellings correspond to the internal grooves, so that the whole appears to

be folded. The thick wall of the cup thus folded consists simply of a system of anastomosing tubes, which open internally into the gastral cavity, and probably also directly to the exterior. On the other hand, the connected interstitial system of spaces between the above tube work is closed on the internal gastral surface of the body, but probably covered externally only by a porous skin, which admits the incurrent water.

Species 1. *Dactylocalyx pumiceus*, Stuchbury.

The body forms a broad flat cup which is borne on a short, somewhat meshed and thin-walled stalk firmly fixed to the substratum. The cup expands into a broad (30 cm.) thin-walled plate- or cup-shaped body, which is laterally provided with a somewhat backward bent, gently sinuous, rounded margin. The radially disposed grooves of the external inferior and internal superior surface here and there exhibit a dichotomous external division. The tubular network is very narrow meshed and the whole thick connected skeleton is firm and strong. It is composed of finely-tubercled beams without thickened nodes of intersection. The loose spicules of the parenchyma are represented by small hexacts with lank, terminally thickened, in part elongated and somewhat curved rays, and also, according to Bowerbank,[1] by oxyhexasters with three long, slightly curved terminals on each of the short principals, and lastly by discohexasters with somewhat long terminals. The oxypentacts described by Sollas are to be referred to the dermal skeleton. There is no trace of uncinates or of scopulæ. Barbados; West Indies.

Species 2. *Dactylocalyx subglobosus*, Gray.

A deep, thick-walled goblet in which the grooves on the gastral or internal surface are less broad than those on the external. The parenchyma contains, besides hexacts with terminal knob-like thickenings (sphærohexacts) numerous discohexasters of various size, with long terminal rays, but *no* oxyhexasters. The tangential rays of the rough dermal pentacts are terminally club-shaped, while the longer proximal radial ray runs out to a point. West Indies.

Species 3. *Dactylocalyx patella*, n. sp.

The dictyonal framework of this probably flat patelliform species, of which only a fragment of macerated skeleton was procured, consists of smooth beams forming an approximately square-meshed network, and forms an anastomosing system of tubes which in many respects resemble those of the other species of *Dactylocalyx*, but are at least twice as broad. (Perhaps identical with *Ioanella compressa*, O. Schmidt, *loc cit.*) Bermuda, 1075 fathoms; coast of Portugal.

[1] *Proc. Zool. Soc. Lond.*, 1869, p. 77, pl. i.

Genus 2. *Margaritella*, O. Schmidt.

With the single species *Margaritella cœloptychioides*, O. Schmidt.

From the somewhat indistinct description and figure given by O. Schmidt,[1] the body of this sponge forms a flat cup, the wall of which consists of a system of connected tubes and equally wide intercanals. The dictyonal framework enclosing polyhedral meshes consists of weakly developed, richly tubercled beams, which are united by slightly thickened nodes of intersection. The latter bear tubercle-like warts where they occur near the surface of the network. The parenchyma contains loose spicules in the form of weakly developed oxyhexacts, delicate oxyhexasters with a few short terminals and very short or wholly reduced principals, and finally somewhat substantial sphærohexasters in which the principal rays are often so much shortened and connected by siliceous masses into a central knot, that the numerous long knobbed terminals appear as if radiated out directly from the centre. The dermal skeleton contains rough pentacts in which the four tangential rays are knobbed, while the proximal radial is simply rounded off or somewhat narrowed at its extremity. Havana, 158 fathoms.

Genus 3. *Scleroplegma*, O. Schmidt.

Thick-walled cup or cylinder in which "the brittle parietal feltwork consists of round or prismatic tubes, which run for the most part obliquely from the outside inwards, either isolated or united in small numbers, and open into the gastral cavity." Between the tubes there are irregular intercanals.[2]

The only species really known to me is *Scleroplegma conicum*, O. Schmidt.

The somewhat smooth internal wall of the spherical goblet exhibits the openings of several wide tubes, arranged in tolerably distinct longitudinal rows. The external surface is traversed by a labyrinth of grooves. The beams of the polyhedral meshwork are beset with transverse rows of conical tubercles, and are united in nodes of intersection, which are thickened especially on the surface of the lattice-work, and beset with groups of tubercle-like warts on the free surface. The loose spicules are quite undetermined. West Indies, 292 fathoms.

Genus 4. *Myliusia*, Gray.

With the single species, *Myliusia callocyathus*, Gray.

A thick-walled substantial cup, with an originally simple plate-shaped wall, from which, by continued parietal folding, a system of tubes has arisen. This system com-

[1] Spongien des Meerbusens von Mexico, p. 54, Taf. vii. fig. 7.

[2] O. Schmidt, *loc. cit.*, p. 56.

municates on the one hand with the funnel-shaped gastral cavity, and on the other hand opens laterally to the exterior by numerous radially disposed and occasionally connected tubes. Between the latter there is a tolerably wide intercanalicular system, which does not open, however, into the gastral space. The polyhedral dictyonal framework, which penetrates and supports the much-folded plate or tube-wall, consists of firm beams, which are beset with numerous transverse rows of small conical tubercles, and united in slightly thickened nodes of intersection, beset with broad tubercled warts. On the dermal and gastral surface of the dictyonal framework there are specially thick nodes of intersection, which never exhibit freely projecting spherical bosses, as in most of the other Dictyonina. The loose spicules of the parenchyma are small lank oxyhexacts, further, oxyhexasters with short principal rays and long S-shaped terminals, disposed in perianth-like fashion, and, lastly, discohexasters with short principals, each with a varying number of long S-shaped externally thickened terminals, forming a tuft and bearing marginally toothed terminal discs. The dermal and gastral skeletons contain pentacts or sword-shaped hexacts with rounded ends, and with a floricome-like discohexaster of the above type, usually attached to the freely projecting radial ray. West Indies; Little Ki Island, 140 fathoms; Timor, 200 fathoms; St. Thomas, West Indies.

Genus 5. *Aulocystis*, n. gen.

The body consists of an anastomosing system of tubes. The dictyonal framework encloses square meshes, *i.e.*, cubical spaces, and consists of tubercled beams, in which the nodes of intersection exhibit twelve oblique rod-like buttresses, extending between the six intersecting beams, so that the sides of a regular octahedron are represented. The parenchyma contains loose oxyhexasters and discohexasters. Oxypentacts occur in the dermal and gastral skeleton. Graphiohexasters are found beneath the skin.

Species 1. *Aulocystis grayi*, Bowerbank.

The octahedral edges of the ("perforate") nodes of intersection in the dictyonal framework are properly not formed of simple, cylindrical, obliquely disposed buttresses, but the external margins of plates which stretch between the intersecting beams, and are transversely perforated by several round pores of various size. Over the free bounding surface of the whole dictyonal framework these plates are so much developed, especially in the tangential direction, that they form here and there, by fusion, a perforate siliceous membrane. The parenchyma contains numerous discohexasters with short principal rays of different sizes, and with a variable number of terminals; also small isolated oxyhexasters, with graphiohexasters here and there under the skin. Discohexasters, with medium-

sized principals and terminals of equal length, such as occur so abundantly in *Aulocystis zittelii*, are here wholly absent. On the pentact dermalia the proximal radial ray is much drawn out. St. Vincent, West Indies.

Species 2. *Aulocystis zittelii*, Marshall.

Pear- or egg-shaped form, from the size of a hen's egg to that of a man's fist. The system of anastomosing thin-walled tubes, as thick as a finger, exhibits a central main passage, or two may be present. From the latter, simple or slightly branched anastomosing tubes radiate outwards, and between these there is an irregular system of wide anastomosing intercanals. The whole system of tubes is covered externally with a thin smooth enveloping capsule, which at the end of the principal passage and lateral tubes exhibits cleft-like or irregularly stellate apertures, while the portions of the capsule above the intercanals consist of a more uniformly porous plate or skin, through which the water enters the sponge. The dictyonal framework supporting the walls of the tubes seems to be very regularly constituted, and consists of beams with pointed tubercles, enclosing meshes usually exactly square or cubical. They are united by nodes of intersection, which are so surrounded by strong beam-like oblique buttresses, with tubercles but without axial canal, that the edges formed from the latter are the edges of a regular octahedron. The direct continuations of the beams within the octahedron are weakly developed and smooth, but provided with axial canals. The loose parenchymalia include small, somewhat regularly formed, oxyhexasters, various discohexasters, isolated delicate graphiohexasters, and in certain regions long oxydiacts with central swelling. The ordinary form of discohexaster is that with medium-sized principals and almost equally long terminals, and more rarely that form with short principals and long delicate terminals, or that with short principals and long strongly developed terminals, with thick terminal discs or knobs. The dermal skeleton consists, like the gastral, of oxypentacts, with rough ends to the rays. There is almost always a rudiment of the atrophied sixth ray represented by a small rounded tubercle. Philippines; West Indies; Little Ki Island, 140 fathoms.

Key for the Determination of Genera and Species.

This Table includes those living Hexactinellida in which the structure is sufficiently well known to admit of accurate characterisation.

		PAGE AND PLATE
A. With amphidiscs and without hexasters, . . .	I.	
B. Without amphidiscs and with hexasters, . . .	VII.	
I. AMPHIDISCOPHORA, including the single family Hyalonematidæ.		
Cup-shaped (exceptionally plate- or ear-shaped) body with a simple round sharply contoured terminal oscular region, ...	II.	
Elongated club-shaped body with internal anastomosing tubular network and narrow lateral oscular zones, .	*Semperella schultzei*, .	261 LI., LII.
II. HYALONEMATINÆ.		
A slender, long, very sharply defined basal tuft of spicules with four-toothed anchor spicules (*Hyalonema*, Gray),	III.	
A broad, short, less sharply separated basal tuft of spicules with bidentate anchor spicules, . . .	IV.	
III. *Hyalonema.*		
The rays of the small parenchymal oxyhexacts are altogether straight, ...	1	
Some of the small parenchymal oxyhexacts have straight rays, while others are distinctly curved, . .	6	
The rays of the small parenchymal oxyhexacts are altogether curved, ...	12	
1 The outer ends of the rays of the small parenchymal oxyhexacts bear outwardly bent lateral spines, .	*Hyalonema cebuense*, .	228
The rays of the small parenchymal oxyhexacts have no curved lateral spines, and are either perfectly smooth or slightly rough, ...	2	
2 Sponge-body of a perfectly conical form with oscular sieve-plate on the broad upper end. The small parenchymal oxyhexacts are rough, . .	3	
Sponge not exactly conical but more or less swollen out. The parenchymal oxyhexacts are smooth, . .	4	
3 The terminal umbels of the larger amphidiscs have slender, pointed marginal rays, . . .	*Hyalonema poculum*, .	208 XXXIII.
The terminal umbels of the larger amphidiscs bear broad, shovel-shaped, marginal rays, . . .	*Hyalonema conus*, .	209 XXXIII.
4 The dermal pinuli have short, somewhat closely appressed lateral spines on the projecting ray, which is always slender and usually ends in a long drawn out point,	*Hyalonema thomsonii*, .	211 XXXIV.
The dermal pinuli have a broad, superiorly truncate, radial ray with long distant lateral spines. There is no oscular sieve-plate, ...	5	

III. *Hyalonema*—continued.		PAGE AND PLATE
5 Body egg-shaped. The gastral pinuli have a long thick, spindle-shaped swollen radial ray, with short lateral teeth. Terminal umbels of the large amphidiscs are arched, ...	*Hyalonema clavigerum*, .	220 XLI.
Body exactly spherical, with firm dermal skeleton. The gastral pinuli have a thin radial ray, with short, curved, lateral spines. Terminal umbels of the large amphidiscs are conical, . . .	*Hyalonema globus*, .	221 XL.
6 Both kinds of parenchymal oxyhexacts, or only those with straight rays bear lateral spines on the rays, .	7	
All the parenchymal oxyhexacts have exclusively smooth rays, ...	8	
7 The lateral spines on the rays of the parenchymal oxyhexacts have their points directed towards the centre. Oscular sieve-plate present, . .	*Hyalonema toxeres*, .	201 XXIX.
The lateral spines on the rays of the parenchymal oxyhexacts are directed towards the exterior. Oscular sieve-plate present, ...	*Hyalonema sieboldii*, .	190 XXVII.
The lateral spines are inserted at right angles to the straight rays of the parenchymal hexacts, . .	*Hyalonema robustum*, .	229 XXXII.
8 Body of an exactly conical form. Large amphidiscs occur with very broad terminal umbels and broad smooth marginal rays. An oscular sieve-plate is present, .	*Hyalonema kentii*, .	207 XXX.
Body more or less swollen out. There are no large amphidiscs, ...	9	
9 The dermal pinuli bear short, strongly developed basal rays, ...	10	
The dermal pinuli have long, slender, basal rays, .	11	
10 The dermal pinuli have a very slender radial ray with apposed short lateral teeth and slender pointed terminal portion. The straight, slender, long, lateral teeth of the terminal truncated amphidisc-terminal umbels diverge inwards. An oscular sieve-plate is present, ...	*Hyalonema divergens*, .	199 XXVIII.
The dermal pinuli have somewhat long lateral teeth on the distal ray. The terminal umbels of the larger amphidiscs are deeply bell-shaped, . . .	*Hyalonema lusitanicum*, .	225 XXVIII., XXXIX.
11 The dermal pinuli have a long, very thin, markedly pointed radial ray, with short closely appressed lateral teeth. The large amphidiscs bear twelve to thirteen lancet-shaped teeth on the margin of the discs,	*Hyalonema tenue*, .	228 XXX.

III. *Hyalonema*—continued. PAGE AND PLATE

The dermal pinuli have moderately long lateral teeth on the long strongly developed radial ray. The large amphidiscs have eight somewhat broad teeth on the margin of the discs, ... *Hyalonema gracile*, . 196 XXVII.

12 The small parenchymal oxyhexacts have oblique inwardly directed lateral spines or barbs on their rays, 13

The rays of the small parenchymal oxyhexacts are quite smooth, ... 14

13 The body has a cup-like or truncated oval form, with wide oscular aperture, without distinct sieve-membrane. The large amphidiscs have broad, hemispherical arched terminal discs with only six broad terminally lancet-shaped marginal rays, . *Hyalonema apertum*, . 214 XXXVII., XXXVIII.

The body is spherical or flat and cake-shaped, with narrow oscular aperture, without distinct sieve-membrane. The large amphidiscs have campanulate terminal discs with eight slender pointed rays, . . *Hyalonema depressum*, . 217 XXXV., XXXVI.

14 The larger, though still comparatively small amphidiscs, have campanulate terminal discs with eight rather long rays, whose pointed ends reach almost to the middle, ... *Hyalonema elegans*, . 223 XXXI.

The larger amphidiscs have an approximately spherical form. The hemispherical terminal umbels exhibit eight to twelve broad terminally rounded marginal rays, which often meet, or alternate with those of the opposite side, ... *Hyalonema tenerum*, 224 XXXI.

IV. Numerous radially projecting pleuralia (*Pheronema*, Leidy), ... V.

Without radial pleuralia. External surface smooth (*Poliopogon*, Wyv. Thomson), . . . VI.

V. *Pheronema*, Leidy.

Body markedly longer than broad, ... 1

Body not longer than broad, ... 3

1 Body egg- or pear-shaped, narrowed superiorly. The basal tuft consists of several isolated tufts of needles, *Pheronema annae*, 239 XLII.

Body resembles a somewhat broad ellipsoid. The broad basal tuft is bushy, ... 2

2 Parallel to the cuff-like wreath of marginalia, projecting as a fringe round the oscular margin, there is below the oscular margin a connected annular zone of pleuralia, measuring about a finger's breadth, . *Pheronema carpenteri*, . 241 XLIII.

V. *Pheronema*—continued.		PAGE AND PLATE
No connected circlet of pleuralia below the oscular border, but somewhat uniformly distributed tufts of pleuralia, ...	*Pheronema giganteum*, .	250 XLV., XLVI.
3 Body resembling a chaffinch's nest, forming about two-thirds of a sphere, with very long basal tufts, .	*Pheronema grayi*, .	246
On the external surface of the body, which occupies three-fourths of a sphere, there is both below the oscular border and above the basis an annular constriction, so that the whole has a bird's-nest form,	*Pheronema hemisphæricum*,	246
The body, which occupies three-fourths of a sphere, has no oscular constriction, and is superiorly somewhat flattened, ...	*Pheronema globosum*, .	248 XLIV.
VI. *Poliopogon*, Wyv. Thomson.		
The body forms an ear-shaped plate. The parenchyma contains no smooth oxydiacts, but only spinose uncinates, ...	*Poliopogon amadou*, .	254 XLIX., L.
The body forms a very thick-walled, approximately spherical goblet. The parenchyma includes small spindle-shaped smooth oxydiacts, . . .	*Poliopogon gigas*, .	257 XLVII., XLVIII.
VII. The skeleton either consists exclusively of isolated spicules, or exhibits synapticula and ladder-like connections, resulting in an irregular secondary union of various large spicules into a connected compact framework (Lyssacina, Zittel, *p.p.*; Hexasterophora, F. E. S.), ...	VIII.	
Besides the isolated spicules there is an early and regular fusion of uniform hexacts, independent of synapticula, and forming a compact connected framework, with no ladder-like structures (Dictyonina, Zittel),	XLIX.	
VIII. HEXASTEROPHORA, F. E. S.		
The dermal skeleton contains hypodermal dagger-shaped hexacts (EUPLECTELLIDÆ), ...	IX.	
The autodermalia and autogastralia are pentact or hexact pinuli, in which the parenchymal radial ray is altogether wanting or only weakly developed (ASCONEMATIDÆ), ...	XIX.	
The autodermalia have no distal radial ray (ROSSELLIDÆ),	XXX.	
IX. EUPLECTELLIDÆ.		
Tubular forms, with terminal sieve-plate and lateral circular parietal pores. On the distal radial ray of the dagger-shaped hexact hypodermalia a floricome is seated (EUPLECTELLINÆ), ...	X.	
Tubular forms without lateral parietal apertures, and without external floricomes (HOLASCINÆ.), . .	XIII.	

		PAGE AND PLATE		
IX.	EUPLECTELLIDÆ—*continued*.			
	The lateral wall of the sack or tube-like body is traversed by irregular parietal apertures of variable form and size, and is partially supported by a framework of united parenchymal spicules. The distal radial ray of the dagger-shaped hexact hypodermalia bears a floricome (TÆGERINÆ), ...	XVI.		
X.	EUPLECTELLINÆ.			
	With basal root-tuft. The parenchyma contains oxyhexasters (*Euplectella*, Owen), . . .	XI.		
	Attached by a firm basis to solid bodies. The parenchyma contains discohexasters (*Regadrella*, O. Schmidt), ...	XII.		
XI.	*Euplectella*, Owen.			
	In each of the meshes which are formed by the intersection of the longitudinal and circular principal strands of fibres, there is a parietal pore. The parietal pores are thus arranged in regular transverse and longitudinal rows, ...	*Euplectella owenii*, .	78	VI.
	Perforate meshes alternate, usually with some regularity, with imperforate, so that the parietal pores are disposed in oblique spiral rows or irregularly, .	1		
1	Curved tube, with externally projecting ridges and superior annular cuff, ...	*Euplectella aspergillum*, .	64	I.–IV.
	Straight tubes, without externally projecting ridges, .	2		
2	In the middle of each parietal convexity, lying between every four parietal pores, there is a strongly developed oxyhexact, with a distal ray projecting for some distance outwards, ...	*Euplectella cucumer*, .	76	
	Without these principal hexacts in the centre of the convex parietal elevation, ...	3		
3	The annular membrane of the parietal gaps contains sceptre-like monacts, ...	4		
	No sceptres in the annular membrane of the parietal gaps, ...	5		
4	The annular membrane of the parietal gaps includes, besides the sceptres, S-shaped clasps, . . .	*Euplectella jovis*, .	77	VI.
	Without S-shaped clasps, ...	*Euplectella suberea*, .	73	V., VI.
5	The abundant parenchymal oxyhexasters have long and extraordinary thick principal rays, . . .	*Euplectella crassistellata*, .	81	XIII.
	Parenchymal oxyhexasters, not as yet observed, and therefore either very sparsely present or altogether absent, ...	*Euplectella nodosa*, .	82	XIV.

			PAGE AND PLTAE
XII.	*Regadrella*, O. Schmidt, with the single species, . .	*Regadrella phœnix*, .	84 XIII.
XIII.	On the internal surface of the somewhat firm and compact tube-wall, there is a rectangular meshwork formed from longitudinal and annular bands, and forming pit-like depressions in the meshes (*Holascus*, F. E. S.), ...	XIV.	
	The internal surface of the very loose body-wall exhibits irregularly distributed round apertures of the efferent canals (*Malacosaccus*, F. E. S.), . .	XV.	
XIV.	*Holascus*, F. E. S.		
	The principalia are oxypentacts or oxyhexacts, . .	1	
	The principalia are oxytetracts, besides which oxyhexacts also occur, ...	2	
	1 The gastralia are hexacts, ...	*Holascus stellatus*, .	86 XIV., XV.
	The gastralia are pentacts, ...	*Holascus polejaevii*, .	89 XVII.
	2 The gastralia are oxypentacts. The parenchyma contains fibulæ, ...	*Holascus fibulatus*, .	87 XV., XVI.
	The gastralia are oxyhexacts. No fibulæ in the parenchyma, ...	*Holascus ridleyi*, .	90 XVII.
XV.	*Malacosaccus*, F. E. S.		
	The parenchyma contains small discohexasters with numerous terminal rays on the transverse terminal discs of the principal rays, . . .	*Malacosaccus vastus*, .	91 XVIII.
	There are in the parenchyma no small discohexasters with numerous terminal rays on the transverse terminal portions of the principal rays. Floricomes with two or five terminal claws on each terminal ray,	*Malacosaccus unguiculatus*,	93 XIX.
XVI.	TÆGERINÆ, F. E. S.		
	Roundish, usually circular parietal gaps. Over the oscular aperture there is an arched cupola of radial spicules (*Tægeria*, F. E. S.), . . .	XVII.	
	Parietal gaps irregular, angular (*Walteria*, F. E. S.), .	XVIII.	
XVII.	*Tægeria*, F. E. S., with the single species, . . .	*Tægeria pulchra*,	94 VII., VIII., XI.
XVIII.	*Walteria*, F. E. S., with the single species, . . .	*Walteria flemmingii*, .	96 IX., X., XI.
XIX.	ASCONEMATIDÆ, F. E. S.		
	The wall of the cup-, funnel-, or tube-shaped body consists of a thin loose plate (ASCONEMATINÆ), . .	XX.	
	The wall of the (always ?) stalked goblet-shaped body is somewhat thick and firm (SYMPAGELLINÆ), .	XXIII.	
	The body has a mushroom-like shape, with long hollow stalk (CAULOPHACINÆ), ...	XXVII.	

			PAGE AND PLATE
XX.	Cup- or funnel-shaped. The principalia are long diacts (*Asconema*, Sav. Kent.), . . .	XXI.	
	Tubular. The principalia include not only long diacts, but also oxyhexacts (*Aulascus*, F. E. S.), . .	XXII.	
XXI.	*Asconema*, Sav. Kent, with the single species, . .	*Asconema setubalense*, .	116 XXI.
XXII.	*Aulascus*, F. E. S., with the single species, . . .	*Aulascus johnstoni*, .	118 XXII
XXIII.	SYMPAGELLINÆ.		
	On each of the terminal branches of a slightly ramified stock, there is a terminal oval goblet. The dermal pinuli are pentacts. The parenchyma contains small " roller stars " (*Sympagella*, O. Schmidt), .	XXIV.	
	The oval body, which is narrow superiorly, contains dermal hexact pinuli (*Polyrhabdus*, F. E. S.), .	XXV.	
	The clay-pipe-like body contains in its parenchyma discohexasters, with long principal rays and short terminals (*Balanites*, F. E. S.), . . .	XXVI.	
XXIV.	*Sympagella*, O. Schmidt, with the single species, . .	*Sympagella nux*, . .	120 XXII.
XXV.	*Polyrhabdus*, F. E. S., with the single species, . . .	*Polyrhabdus oviformis*, .	121 XXIII.
XXVI.	*Balanites*, F. E. S., with the single species, . . .	*Balanites pipetta*. .	122 XXIII.
XXVII.	CAULOPHACINÆ, F. E. S.		
	The body, which is flattened from above downwards, is either biconvex, or convex above and concave below by the folding over of the marginal portion. Without sickle-rosettes in the stalk (*Caulophacus*, F. E. S.),	XXVIII.	
	With sickle-rosettes in the long, hollow, rough stalk (*Trachycaulus*, F. E. S.), ...	XXIX.	
XXVIII.	*Caulophacus*, F. E. S.		
	The margin of the body is folded over downwards. On the convex gastral surface there are long pentact pinuli,	*Caulophacus latus*, .	124 XXIV.
	The disc of the body is biconvex or with a downward folded border. The gastral pinuli are all hexacts, .	*Caulophacus elegans*, .	126 XXV., XXVI.
XXIX.	*Trachycaulus*, F. E. S., with the single species, . .	*Trachycaulus gurlittii*, .	128 XXVI.
XXX.	ROSSELLIDÆ.		
	Unstalked (or quite shortly stalked), cup- or sack-shaped forms, ...	XXXI.	
	Seated on a distinct long stalk, . . .	XLIV.	
XXXI.	Principalia do not tend to become soldered together, nor do they even in old specimens form a connected framework, ...	XXXII.	
	The principalia, which show a tendency to be united and soldered together by synapticula, form in the older parts of the body a connected framework, . .	XLIII.	

			PAGE AND PLATE
XXXII.	External surface surrounded by a veil of tangential rays belonging to pentact pleuralia. The autodermalia are predominantly pentacts (*Rossella*, Carter),	XXXIII.	
	External surface without a veil of tangential rays,	XXXIV.	
XXXIII.	*Rossella*, Carter.		
	The four tangential rays of the pentact pleuralia intersect at right angles,	*Rossella velata*,	143
	The four tangential rays of the pentact pleuralia do not intersect at right angles but form acute angles with one another,	*Rossella antarctica*,	139 LV.
XXXIV.	The external surface of the body bears radially projecting papillæ, from each of which a tuft of long pleuralia projects. The root tuft is fixed in the mud (*Polylophus*, F. E. S.),	XXXV.	
	The external surface of the body bears no papillæ or basal tuft,	XXXVI.	
XXXV.	*Polylophus*, F. E. S., with the single species,	*Polylophus philippinensis*,	133 LIII., LIV.
XXXVI.	Body-wall thin and loose. Oscular margin (always?) with a cuff-like fringe of marginalia (*Bathydorus*, F. E. S.),	XXXVII.	
	Body-wall somewhat thick and firm. Oscular border smooth, without marginalia,	XXXVIII.	
XXXVII.	*Bathydorus*, F. E. S.		
	The autodermalia consist solely of rough oxytetracts,	1	
	The autodermalia consist solely of diacts and monacts. The parenchyma contains besides oxyhexasters also discohexasters,	*Bathydorus baculifer*,	154 LIX.
	1 In many of the parenchymal oxyhexasters the principal rays are very much shortened, and the terminals thus appear to spring directly from a central node,	*Bathydorus stellatus*,	152 LIX.
	The terminal rays of the parenchymal oxyhexasters all spring from developed principals,	2	
	2 The terminal rays of many parenchymal oxyhexasters are curved in an S-shaped fashion,	*Bathydorus fimbriatus*,	151 LVIII.
	The terminal rays of many parenchymal oxyhexasters are somewhat undulating in their curvature,	*Bathydorus spinosus*,	153 LIX.
XXXVIII.	From the external surface of the body pointed pleuralia project, either isolated or united in tufts. The autodermalia are pentacts and tetracts (*Acanthascus*, F. E. S.),	XXXIX.	
	The external surface of the body is smooth, without pleuralia,	XL.	

			PAGE AND PLATE
XXXIX.	*Acanthascus*, F. E. S.		
	The dermal skeleton contains exclusively pentacts, .	*Acanthascus dubius*, .	147 LVII.
	The dermal skeleton contains pentacts and tetracts, .	1	
1	Isolated pleuralia, ...	*Acanthascus grossularia*, .	145 LVI.
	Pleuralia projecting in groups from small elevations on the external surface, ...	*Acanthascus cactus*, .	148 LVII.
XL.	The autodermalia of the cocoon-shaped body are all tetracts (*Lanuginella*, O. Schmidt), . .	XLI.	
	Besides the tetract autodermalia many diacts occur (*Rhabdocalyptus*, F. E. S.), . . .	XLII.	
XLI.	*Lanuginella*, O. Schmidt, with the single species, . .	*Lanuginella pupa*, .	130 LIII.
XLII.	*Rhabdocalyptus*, F. E. S.		
	Funnel-shaped. Autodermalia exclusively diacts, .	*Rhabdocalyptus mollis*, .	155 LXIV.
	Sack-shaped. Autodermalia are pentacts, tetracts, diacts and monacts, ...	*Rhabdocalyptus roeperi*, .	158 LXV.
XLIII.	With great parenchymal hexasters, in which each of the short principal rays bears six long diverging terminals, which gradually increase in thickness towards the round outer end, and are beset all round with backwardly bent pointed hooks (*Aulocalyx*, F. E. S.), with the single species, .	*Aulocalyx irregularis*, .	174 LX.
	Without such great hexasters, whose long terminal rays increase in thickness towards the round outer end, and are beset all round with backwardly bent pointed hooks (*Euryplegma*, F. E. S.), with the single species, ...	*Euryplegma auriculare*, .	176 CII.
XLIV.	From the lateral surface of the body long pleural diacts project (*Caulocalyx*, F. E. S.), . . .	XLV.	
	The external surface of the body is smooth, . .	XLVI.	
XLV.	*Caulocalyx*, F. E. S., with the single species, . . .	*Caulocalyx tener*, .	172 LXIX.
XLVI.	The oscular margin is not folded back, but remains upright, surrounding with a sharp fringe the superior gastral cavity opening of the cup-shaped body (*Crateromorpha*, Gray), ...	XLVII.	
	The oscular margin is folded back for some distance so that a portion of the gastral surface forms the external wall of the body (*Aulochone*, F. E. S.), .	XLVIII.	
XLVII.	*Crateromorpha*, Gray.		
	Body (not including stalk), higher than broad, . .	1	
	Body (not including stalk), broader than high, . .	2	

		PAGE AND PLATE
XLVII. *Crateromorpha*—continued.		
1 The form of the body is tulip-like. The oscular fringe forms a thin annular plate almost 1 cm. in height. The terminal rays of the parenchymal oxyhexasters are straight, ...	*Crateromorpha meyeri*, .	161 LXI.
The form of the body is oval. The oscular marginal fringe is inconspicuous, about 2 mm. The terminal rays of the parenchymal oxyhexasters are distinctly S-shaped, ...	*Crateromorpha thierfelderi*,	164 LXII.
2 The oscular marginal fringe is sharply angular, and forms the broadest portion of the body. The terminal rays of the parenchymal oxyhexasters are bent round at their extremities, . . .	*Crateromorpha murrayi*,	164 LXIII.
The oscular fringe is less extended than the median portion of the puffed out body. The terminal rays of the parenchymal oxyhexasters are straight, .	*Crateromorpha tumida*, .	166 LXVII., LXVIII.
XLVIII. *Aulochone*, F. E. S.		
The parenchyma contains, besides other spicules, floricomes, ...	*Aulochone lilium*, .	171 LXVIII.
The floricomes are altogether absent, ...	*Aulochone cylindrica*, .	168 LXVI , LXVIII.
XLIX. Dictyonina, Zittel.		
With distinctly developed uncinates (Uncinataria, F. E. S.), ...	L.	
Without distinct uncinates (Inermia), . . .	LXX.	
L. Uncinataria.		
The dermal and gastral skeletons contain clavulæ (Clavularia), ...	LI.	
Without clavulæ, but with scopulæ (Scopularia), .	LII.	
LI. Clavularia, with the single family Farreidæ, and the single genus *Farrea*, Bwk.		
Branched tubular stock with a straight principal stem, the dermal clavulæ have mostly smooth edges, .	*Farrea clavigera*, .	287 LXXV.
Branched anastomosing tubular stocks, without a straight principal stem, ...	1	
1 The parenchyma contains no discohexasters, . .	*Farrea occa*, . .	277 LXXI.–LXXIII., LXXVI.
Discohexasters occur in the parenchyma, . .	2	
2 The hexasters occurring in the parenchyma are exclusively discohexasters, with long terminal rays, .	*Farrea sollasii*, . .	286 LXXIV.
Of the parenchymal hexasters, some are oxyhexasters, with short terminal rays, and others discohexasters, with long terminals, ...	*Farrea vosmaeri*, .	286 LXXIV.

			PAGE AND PLATE	
LII.	SCOPULARIA.			
	The dictyonal framework exhibits a honeycomb-like structure; the wall of the cup or tube-like skeleton is regularly traversed by hexagonal parietal apertures (MELITTIONIDÆ), ...	LIII.		
	The dictyonal skeleton exhibits no such honeycombed structure, ...	LIV.		
LIII.	MELITTIONIDÆ, with the single genus *Aphrocallistes*, Gray .			
	The body consists of a dichotomously branched tube, .	*Aphrocallistes ramosus*, .	317	LXXXVI.
	The body has the form of a cup with lateral diverticula,	1		
1	The traverse lateral diverticula of the cup-shaped body are flat and pouch-like, and disposed perpendicularly. The parenchyma contains no oxy-, but only disco- and sphæro-hexasters, . . .	*Aphrocallistes vastus*, .	315	LXXXV.
	The lateral diverticula are glove-finger-shaped. The parenchyma contains oxyhexasters, . .	2		
2	The oxyhexasters of the parenchyma are all much elongated in a longitudinal direction. The four principal rays at right angles to the latter, remain simple and short, ...	*Aphrocallistes beatrix*, .	309	LXXXIV.
	The oxyhexasters of the parenchyma are, for the most part, uniformly stellate. Some sphærohexasters occur, ...	*Aphrocallistes bocagei*, .	311	LXXXIII., LXXXIV.
LIV.	Body plate or cup-shaped. The dictyonal framework exhibits regularly alternating, straight, or funnel-shaped passages, belonging to the afferent and efferent canals, which penetrate the body wall transversely (COSCINOPORIDÆ), ...	LV.		
	The dictyonal framework does not exhibit regularly alternating, straight, afferent and efferent passages, traversing the wall, ...	LVII.		
LV.	COSCINOPORIDÆ, Zittel, with the single genus *Chonelasma*, F.E.S.			
	The body has a flat tabular form, ...	LVI.		
	The body has the form of a cup with lateral thimble-like diverticula, ...	*Chonelasma calyx*, .	324	LXXXIX.
LVI.	The dermal skeleton contains strongly developed pentacts, without rudiment of a sixth distal ray, and with tangential rays beset with spines on the outer surface, ...	*Chonelasma lamella*, .	319	LXXXVII., LXXXVIII.
	Hexacts occur in the dermal skeleton, with a short distal laterally spinose ray, ...	1		
1	The parenchyma contains discohexasters, with long rough principal rays, and short S-shaped terminals,	*Chonelasma hamatum*, .	321	XCI.

			PAGE AND PLATE
LVI.—continued.	The parenchymal discohexasters have only short principal rays, ...	*Chonelasma dœderleinii,*	322 XC.
LVII.	The body consists of a system of branched anastomosing tubes, which form either an irregular feltwork, or the wall of a cup (Euretidæ, F. E. S.), . .	LVIII.	
	The more or less thick wall of the usually cup-shaped body is traversed by oblique or curved afferent and efferent canals (Tretodictyidæ), . .	LXIII.	
LVIII.	The tubular feltwork does not enclose a central funnel-shaped cavity. *Eurete* (*Semper*), Carter, . .	LIX.	
	The anastomosing tubular work encloses a central funnel-shaped cavity, and thus forms the wall of a cup, ...	LX.	
LIX. *Eurete*, Carter.	The dermal scopulæ have four smooth prongs, with spindle or club-shaped extremities, . .	*Eurete semperi,* .	. 292 LXXVII.
	The dermal scopulæ bear smooth pointed prongs, .	*Eurete schmidtii,*	. 293 LXXVIII.
	The dermal scopulæ bear prongs, with club-shaped barbed extremities, ...	1	
1	The parenchyma contains oxyhexasters whose principal rays are about twice as long as the short terminals,	*Eurete bowerbankii,*	. 297 LXXIX.
	The parenchyma contains exclusively hexasters whose principal rays are much shorter than the terminals,	2	
2	The hexasters of the parenchyma all bear long pointed terminal rays, ...	*Eurete marshalli,*	. 297 LXXIX.
	The hexasters of the parenchyma are provided with knobs or transverse discs at the end of their terminal rays, and are therefore sphæro- or discohexasters, .	3	
3	Both the dermal and gastral scopulæ exhibit a distinct break-like bend on the pedicel of the prongs, .	*Eurete farreopsis,*	. 295 LXXIX.
	The pedicels of the prongs are not thus bent either in the dermal or gastral scopulæ, but are straight or gently curved, ...	*Eurete carteri,* .	. 296 LXXVIII.
LX.	The internal surface of the cup-shaped body exhibits no longitudinal ridges on the dictyonal skeleton. The whole body-wall consists of a loose feltwork of thin-walled tubes (*Periphragella*, Marshall), .	LXI.	
	On the internal surface of the somewhat firm dictyonal framework of the cup-shaped body there are distinct firm longitudinal ridges (*Lefroyella*, Wyv. Thomson),	LXII.	
LXI. *Periphragella*, Marshall, with the single species,	. .	*Periphragella elisæ,*	. 299 LXXX., LXXXI.

			PAGE AND PLATE
LXII.	*Lefroyella*, Wyv. Thomson, with the single species, . .	*Lefroyella decora*, .	301 LXXXII.
LXIII.	TRETODICTYIDÆ, F. E. S.,		
	Bush-like ramified stock with somewhat solid cylindrical branches, on which annular or spiral zones of incurrent and excurrent regions alternate (*Sclerothamnus*, Marshall), ...	LXIV.	
	Body cup-, tube-, or ear-shaped, ...	LXV.	
LXIV.	*Sclerothamnus*, Marshall, with the single species, . .	*Sclerothamnus clausii*, .	337 XCVIII.
LXV.	Body surrounded by a leaf-like enveloping capsule (*Fieldingia*, Sav. Kent), ...	LXVI.	
	Body without leaf-like enveloping capsule, . .	LXVII.	
LXVI.	*Fieldingia*, Sav. Kent, with the single species, . .	*Fieldingia lagettoides*, .	333 XCVII.
LXVII.	The parenchyma contains scopula-like spicules bearing numerous prongs with transverse terminal discs springing from a terminal knob on the long pedicel (*Cyrtaulon*, F. E. S.), ...	LXVIII.	
	Body in the form of a ramified, slightly anastomosing tubular feltwork, or of a cup, in which the thick wall is traversed by oblique, or twisted afferent and efferent canals, without scopula-like parenchymal spicules with radial prongs (*Hexactinella*, Carter), .	LXIX.	
LXVIII.	*Cyrtaulon*, F. E. S.		
	The body-wall is supported by a feltwork of plates of the dictyonal framework, which enclose round cavities. The nodes of intersection are here and there thickened, and near the surface of the body beset with warts, ...	*Cyrtaulon sigsbeei*, .	331 XCII.
	The dictyonal framework forms an irregular network of beams and strands which traverse the cylindrical body. Nodes of intersection without thickening or warts, ...	*Cyrtaulon solutus*, .	331 XCII.
LXIX.	*Hexactinella*, Carter.		
	The body consists of a dichotomously ramified feltwork of uniformly wide, here and there anastomosing tubes,	*Hexactinella tubulosa*, .	326 XCIII.
	The body consists of a dichotomously branched tube, the terminal twigs of which exhibit funnel-shaped expansions, ...	*Hexactinella lata*, .	327 XCIV., XCV.
	The body forms a cap seated on a firm basis, becoming markedly wide, but somewhat laterally compressed,	*Hexactinella ventilabrum*,	329 XCVI.
LXX.	The body consists of a system of thin-walled tubes of approximately uniform calibre, with an intermediate system of cavities (MÆANDROSPONGIDÆ), . .	LXXI.	

			PAGE AND PLATE
LXXI.	MÆANDROSPONGIDÆ, Zittel.		
	The very regular dictyonal framework enclosing cubical meshes has perforated nodes of intersection with octahedral edges (*Aulocystis*, F. E. S.), . .	LXXII.	
	The nodes of intersection of the dictyonal framework are simple and imperforate, . . .	LXXIII.	
LXXII.	*Aulocystis*, F. E. S.		
	The octahedral edges of the perforated nodes of intersection of the dictyonal framework are formed of simple oblique round buttresses. The parenchyma contains abundant discohexasters in which the terminal rays are as long as the principals, . .	*Aulocystis zittelii*, .	359 CIV.
	The octahedral edges of the perforate nodes of the dictyonal framework are formed of the sometimes repeatedly perforate plates, which extend between the intersecting beams. The principal rays of the parenchymal discohexasters are much shorter than the terminals, ...	*Aulocystis grayi*, . .	357 CIV.
LXXIII.	The nodes of intersection of the dictyonal framework are thickened and beset with broad tuberculate warts (*Myliusia*, Gray), ...	LXXIV.	
	The nodes of intersection of the dictyonal framework possess no broad tuberculate warts (*Dactylocalyx*, Stutchbury), ...	LXXV.	
LXXIV.	*Myliusia*, Gray, with the single species, . . .	*Myliusia callocyathus*, .	352 CIII.
LXXV.	*Dactylocalyx*, Stutchbury.		
	The body forms a flatly expanded thick-walled cup, which consists of a system of narrow tubes, only 1 to 2 mm. in width. The parenchyma contains, besides other isolated spicules, oxyhexasters, . . .	*Dactylocalyx pumiceus*, .	346
	The body forms a deep thick-walled goblet, which consists of a system of narrow (only 1 to 2 mm. in width) tubes. No oxyhexasters in the parenchyma, ...	*Dactylocalyx subglobosus*,	347 XCIX.
	The flat body consists of tubes 3 to 5 mm. in width, .	*Dactylocalyx patella*, .	348 C.

GEOGRAPHICAL DISTRIBUTION.

HISTORY.

A careful synopsis of the habitats of all the Hexactinellida definitely known in 1873 is given by Carter in his memoir On the Hexactinellidæ and Lithistidæ.[1] The results of Carter's summary are tabulated here with several additions, and with the use of the specific designations which I have adopted.

Species.	Locality.
1. *Euplectella aspergillum*, Owen.	Philippines.
2. *Euplectella cucumer*, Owen.	Seychelles.
3. *Habrodictyum speciosum*, Wyville Thomson.	Moluccas.
4. *Asconema setubalense*, Sav. Kent.	Portugal.
5. *Sympagella nux*, O. Schmidt.	Florida.
6 *Lanuginella pupa*, O. Schmidt.	Cape Verde Islands, St. Iago.
7. *Polylophus philippinensis*, Gray.	Philippines.
8. *Rossella antarctica*, Carter.	Antarctic Sea (South Pacific).
9. *Rossella velata*, Wyville Thomson.	South of Færöe Islands.
10. *Crateromorpha meyeri*, Gray.	Philippines, Zebu.
11. *Hyalonema sieboldii*, Gray.	Japan.
12. *Hyalonema lusitanicum*, Bocage.	Portugal.
13. *Pheronema annæ*, Leidy.	Santa Cruz, West Indies.
14. *Pheronema carpenteri*, Wyville Thomson.	South of Færöe Islands.
15. *Pheronema grayi*, Sav. Kent.	Portugal.
16. *Pheronema hemisphærica*, Gray.	Philippines, Zebu.
17. *Semperella schultzei*, Semper.	Philippines, Zebu.
18. *Farrea occa*, Carter.	Seychelles.
19. *Farrea* sp. (*woodwardi*, Sav. Kent).	Portugal.
20. *Farrea* sp. (*facunda*, O. Schmidt).	Between Florida and Cuba.
21. *Farrea* (?) *infundibularis*, Carter.	Caribbean Sea, West Indies.
22. *Eurete* sp. (*simplicissima*, Semper).	Philippines, Zebu.
23. *Aphrocallistes bocagei*, Wright.	Portugal.
24. *Aphrocallistes beatrix*, Gray.	Malacca.
25. *Fieldingia lagettoides*, Sav. Kent.	Portugal.
26. *Dactylocalyx pumiceus*, Stutchbury.	Barbados, West Indies.
27. *Dactylocalyx subglobosus*, Gray.	Malacca.
28. *Myliusia callocyathus*, Gray.	West Indies.
29. *Aulocystis grayi*, Bowerbank.	St. Vincent, West Indies.

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xii. p. 349.

From this it appears that in 1873 six specimens were known from the neighbourhood of Portugal, viz :—

1. *Asconema setubalense*, Sav. Kent.
2. *Hyalonema lusitanicum*, Bocage.
3. *Pheronema grayi*, Sav. Kent.
4. *Farrea* sp.
5. *Aphrocallistes bocagei*, Wright.
6. *Fieldingia lagettoides*, Sav. Kent.

from the Philippines six species were also known, viz.:—

1. *Euplectella aspergillum*, Owen.
2. *Polylophus philippinensis*, Gray.
3. *Crateromorpha meyeri*, Gray.
4. *Pheronema hemisphæricum*, Gray.
5. *Semperella schultzei*, Semper.
6. *Eurete* sp. (*simplicissima*, Semper).

and from the West Indies five species :—

1. *Pheronema annæ*, Leidy.
2. (*Farrea ?*) *infundibularis*, Carter.
3. *Dactylocalyx pumiceus*, Stutchbury.
4. *Myliusia callocyathus*, Gray.
5. *Aulocystis grayi*, Bowerbank.

and lastly, one or two species from widely separated localities.

From a list published a few years ago by Marshall,[1] in which several additional forms were included, and a few bathymetrical data were also furnished, the author drew the following conclusions (*op. cit.*, p. 151) :—"From this survey it is seen that the Hexactinellida have a horizontal distribution from about 65° north latitude to about 50° south, and a vertical distribution from about 500 to over 4000 fathoms. It may seem striking that several localities have yielded a relatively large number of Hexactinellid species, *e.g.*, Portugal, Florida (and the West Indies), and the Philippines, but it must be noted that the two first regions have been specially explored by deep-sea expeditions, while the Philippines are the home of an exceedingly keen fishing folk, who are wide awake to the fact that any new form means gold to the finder."

Without entering on any detailed review of the several reports which have been made on the distribution of the Hexactinellida, I shall tabulate all the trustworthy and definite notices of locality with which I am acquainted, so far as they refer to sufficiently defined species. The first of the two synoptic tables is arranged zoologically according to my system, the second according to the localities. I have further marked all the localities on the accompanying map of the world. In this way the state of knowledge independent of the results of the Challenger Expedition is clearly indicated.

[1] *Zeitschr. f. wiss. Zool.*, 1875, Bd. xxv. Suppl., p. 150.

TABLE I.—Synopsis of the Hexactinellida hitherto known, with their Habitats, as ascertained apart from the Challenger Collection.

A. *Clearly defined Forms.*

Species.	Habitat.	Depth in Fathoms.	Authority.
1. *Euplectella aspergillum*, Owen,	1. Philippines,	...	Owen.
	2. Philippines (Bohol, Zebu),	...	Bowerbank.
	3. Philippines,	...	Semper.
	4. Philippines (near Zebu),	...	Gray.
	5. Philippines (Zebu),	...	Moore.
	6. Philippines (Zebu),	...	Chimmo and others.
2. *Euplectella subcrea*, Wyv. Thomson,	1. North of Scotland,	...	Wyv. Thomson.
	2. Widely distributed in the N. Atlantic,	450–1100	Filhol.
3. *Euplectella cucumer*, Owen,	Seychelles Islands,	...	Owen.
4. *Euplectella jovis*, O. Schmidt,	Gulf of Mexico, St. Lucia, Grenada,	416 and 423	O. Schmidt.
5. *Euplectella oweni*, Herkl. and Marshall,	Japan,	...	Marshall.
Euplectella oweni, Herkl. and Marshall,	Japan (Sagami Bay),	100–200	Döderlein.
6. *Regadrella phœnix*, O. Schmidt,	Gulf of Mexico, Barbados, Santa Cruz,	221, 248, and 288	O. Schmidt.
7. *Habrodictyum speciosum*, Quoy and Gaimard,	Moluccas, Mauritius,	...	Quoy and Gaimard.
			Valenciennes.
8. *Dictyocalyx gracilis*, F. E. Schulze,	Gulf of Mexico (Bequia),	1591	O. Schmidt.
9. *Rhabdodictyum delicatum*, O. Schmidt,	Gulf of Mexico (Bequia),	1591	O. Schmidt.
10. *Rhabdopectella tintinnus*, O. Schmidt,	Gulf of Mexico (Grenada),	291, 994	O. Schmidt.
11. *Hertwigia falcifera*, O. Schmidt,	Gulf of Mexico (Dominica),	611	O. Schmidt.
12. *Asconema setubalense*, Sav. Kent,	1. Portugal (Cape St. Vincent),	...	Saville Kent, Filhol.
	2. North-west of Scotland,	327–430	John Murray.
13. *Sympagella nux*, O. Schmidt,	Florida,	98–123	O. Schmidt.
14. *Lanuginella pupa*, O. Schmidt,	Cape Verde Islands (St. Iago),	...	O. Schmidt.
15. *Polylophus philippinensis*, Gray,	Philippines (Zebu),	...	A. B. Meyer.
16. *Rossella antarctica*, Carter,	Antarctic Ocean, lat. 74° S., long. 175° W.,	...	J. Ross, Carter.
17. *Rossella velata*, Wyv. Thomson,	West of Strait of Gibraltar,	651	Wyv. Thomson.
18. *Acanthascus cactus*, F. E. S.,	Japan (Sagami Bay),	100–200	Döderlein.
19. *Rhabdocalyptus mollis*, F. E. S.,	Japan (Sagami Bay),	100–200	Döderlein.
20. *Crateromorpha meyeri*, Gray,	1. Philippines (Zebu),	...	Gray.
	2. Japan (Sagami Bay),	100–200	Döderlein.
21. *Hyalonema sieboldii*, Gray,	Japan (Sagami Bay),	100–200	Gray.
			Semper.
			Max Schultze, Hilgendorf, Döderlein, and others.
22. *Hyalonema kentii*, O. Schmidt,	West Indies { Grenada,	338, 576	} O. Schmidt.
	Martinique,	565	
	Guadeloupe,	583	
	Bequia,	1507	
23. *Hyalonema* (*Stylocalyx*) *thomsonii*, Marshall,	North of Shetland Islands,	550	W. Marshall.
24. *Hyalonema* sp., Wyv. Thomson,	North of Hebrides,	...	Wyv. Thomson.
25. *Hyalonema lusitanicum*, Bocage,	Portugal,	...	Bocage.
	Portugal,	...	Saville Kent.
26. *Hyalonema cebuense*, Higgin,	Philippines (Zebu),	...	Higgin.
27. *Pheronema annæ*, Leidy,	West Indies (Santa Cruz),		Leidy.
	... ...	180, 248	O. Schmidt.
28. *Pheronema grayi*, Sav. Kent,	Portugal (Setubal),	...	Sav. Kent.
29. *Pheronema carpenteri*, Wyv. Thomson,	From Butt of Lewis (Hebrides) to Gibraltar,	{ 500–1000 (300–800) }	Wyv. Thomson.
30. *Pheronema hemisphæricum*, Gray,	1. Singapore,	...	Gray.
	2. Philippines (Zebu),	...	Marshall and Meyer.
31. *Semperella schultzei*, Semper,	1. Philippines,	...	Semper.
	2. Philippines (Zebu),	...	Marshall and Meyer.
32. *Farrea* sp. (*occa*, Bowerbank),	Seychelle Island,	...	Owen.
Farrea sp. (*occa*, Bowerbank),	Portugal,	...	Sav. Kent.
33. *Farrea occa* (Bowerbank), Carter,	Japan (Misaki),	...	Carter, Döderlein.
34. *Farrea sollasii*, F. E. S.,	Japan (Sagami Bay),	100–200	Döderlein.
35. *Farrea vosmaeri*, F. E. S.,	Japan (Sagami Bay),	100–200	Döderlein.
36. *Farrea* sp. (*woodwardi*, Sav. Kent),	Portugal,	...	Sav. Kent.
37. *Eurete* sp. (*simplicissima*, Semper),	Philippines,	...	Semper.
38. *Eurete* sp.,	Philippines (Zebu),	...	Marshall and Meyer.
39. *Eurete schmidtii*,	Japan (Sagami Bay),	100–200	Döderlein.
40. *Eurete farreopsis*, Carter,	Philippines,	...	Carter.
41. *Eurete* sp.,	Japan (Sagami Bay),	100–200	Döderlein.

TABLE I.—*continued.*

Species.	Habitat.	Depth in Fathoms.	Authority.
42. *Periphragella elisæ*, Marshall,	1. Moluccas,	...	Marshall.
	2. Japan (Sagami Bay),	100–200	Döderlein.
43. *Aphrocallistes bocagei*, Perceval Wright,	Cape Verde Islands, Japan,	...	Perceval Wright.
	South-east of Florida, Gulf of Mexico,	...	O. Schmidt.
	Coast of Spain and Portugal,	...	Sav. Kent, Milne-Edwards, Filhol, and others.
44. *Aphrocallistes ramosus*, F. E. S.,	Japan (Sagami Bay),	100–200	Döderlein.
45. *Aphrocallistes vastus*, F. E. S.,	Japan (Sagami Bay),	100–200	Döderlein, Gottsche.
46. *Chonelasma doederleinii*, F. E. S.,	Japan (Sagami Bay),	100–200	Döderlein.
47. *Chonelasma calyx*, F. E. S.,	Japan (Sagami Bay),	100–200	Döderlein.
48. *Hexactinella ventilabrum*, Carter,	Japan (Sagami Bay),	100–200	Carter, Döderlein.
49. *Hexactinella tubulosa*, F. E. S.,	Japan (Sagami Bay),	100–200	Döderlein.
50. *Cyrtaulon sigsbeei*, O. Schmidt,	Gulf of Mexico {(Barbados, Morrolight, St. Vincent),	100–292	O. Schmidt.
51. *Fieldingia lagettoides*, Sav. Kent,	Portugal,	...	Sav. Kent.
52. *Sclerothamnus clausii*, Marshall,	... ...	...	Marshall.
	Philippines (Zebu),	...	Murie.
53. *Dactylocalyx pumiceus*, Stutchbury,	West Indies (Barbados, St. Vincent),	...	Stutchbury, O. Schmidt.
54. *Dactylocalyx subglobosus*, Gray,	Malacca,	...	Gray.
	West Indies (St. Lucia),	116	O. Schmidt.
	West Indies (North-west of Havanna),	190	O. Schmidt.
55. *Scleroplegma conicum*, O. Schmidt,	West Indies (Morrolight),	292	O. Schmidt.
56. *Myliusia callocyathus*, Gray,	West Indies,	...	Gray.
57. *Aulocystis grayi*, Bowerbank,	West Indies (St. Vincent),	...	Bowerbank.
58. *Aulocystis zittelii*, Marshall,	Barbados,	100	O. Schmidt.
	Philippines (Zebu),	...	Meyer and Marshall.
	West Indies (Guadeloupe),	150	O. Schmidt.

B. *Insufficiently defined Forms.*

Species.	Habitat.	Depth in Fathoms.	Authority.
1. *Euplectella* sp.,	North Sea,	...	Bowerbank.
2. *Euplectella* sp.,	Between Ireland and the Færöe Islands,	...	Carter.
3. *Euplectella* sp.,	Mediterranean,	...	Marshall.
4. *Holtenia pourtalesii*, O. Schmidt,	Florida (Sand Key),	154–324	O. Schmidt.
5. *Holtenia saccus*, O. Schmidt,	Florida,	...	O. Schmidt.
6. *Hyalonema sieboldi?*	Between England and Ireland,	...	Carter.
7. *Hyalonema* sp.,	Gulf of Mexico (Grenada),	416	O. Schmidt.
8. *Leiobolidium*, O. Schmidt,	Gulf of Mexico (Bequia),	1507	O. Schmidt.
9. Lyssacine,	West of Norway,	1081	Armauer Hansen.
10. *Farrea facunda*, O. Schmidt,	Florida, Cuba, Gulf of Mexico,	...	O. Schmidt.
11. *Farrea infundibuliformis*, Carter,	Caribbean Sea,	...	Carter.
12. *Farrea gassioti*, Bowerbank,	West Indies,	...	Bowerbank.
13. *Farrea pocillum*, Bowerbank,	West Indies,	...	Bowerbank.
14. *Farrea parasitica*, Bowerbank,	West Indies,	...	Bowerbank.
15. *Farrea spinulenta*, Bowerbank,	Tripoli,	...	Bowerbank.
16. *Farrea perarmata*, Bowerbank,	West Indies,	...	Bowerbank.
17. *Farrea irregularis*, Bowerbank,	Algiers,	...	Bowerbank.
18. *Diaretula cornu*, O. Schmidt,	Gulf of Mexico (Morrolight),	805	O. Schmidt.
19. *Diaretula muretta*, O. Schmidt,	Gulf of Mexico (Morrolight),	805	O. Schmidt.
20. *Cyathella lutea*, O. Schmidt,	Gulf of Mexico (Bequia),	1591	O. Schmidt.
21. *Syringidium zittelii*, O. Schmidt,	Gulf of Mexico {St Lucia,	116	O. Schmidt.
	Martinique,	136	
	Santa Cruz,	218, 245	
	Guadeloupe,	138, 150, 878	
	Morrolight,	200–450	
22. *Cystispongia superstes*, O. Schmidt,	Gulf of Mexico {Yukatan,	20 (?)	
	Morrolight,	292	
	Martinique,	136	
23. *Dactylocalyx potatorum*, O. Schmidt,	Gulf of Mexico, St. Lucia,	151	O. Schmidt.
24. *Joanella compressa*, O. Schmidt,	Gulf of Mexico, 23° 2′ N., 83° 13′ W.,	287	O. Schmidt.
25. *Scleroplegma lanterna*, O. Schmidt,	Gulf of Mexico {23° 4′ N.,	320	O. Schmidt.
	(Morrolight),	292	
26. *Scleroplegma seriatum*, O. Schmidt,	Gulf of Mexico (Morrolight),	200–300	O. Schmidt.
27. *Scleroplegma herculeum*, O. Schmidt,	Gulf of Mexico (Santa Cruz),	580	O. Schmidt.
	25° 33′ N., 83° 21′ W.,	101	
28. *Diplacodium mixtum*, O. Schmidt,	Gulf of Mexico (Morrolight),	292	O. Schmidt.
29. *Pachaulidium* sp.?, O. Schmidt,	Gulf of Mexico (Santa Cruz),	580	O. Schmidt.
30. *Rhabdostauridium retortula*, O. Schmidt,	Gulf of Mexico, 23° 54′ N., 88° 55′ W.,	804	O. Schmidt.

TABLE II.—Synopsis of the Habitats of Hexactinellida, as known apart from the Challenger Collection, arranged Geographically.

I.—ATLANTIC OCEAN.

Locality	Depth in Fathoms.	Species.	Authority.
A. Mediterranean.			
1. Algiers,	...	Dictyonine (*Farrea irregularis*, Bowerbank),	Bowerbank.
2. Tripoli,	...	Dictyonine (*Farrea spinulenta*, Bowerbank),	Bowerbank.
3. Naples,	...	Dictyonine,	F. E. Schulze.
4. Mediterranean,	...	Lyssacine (*Euplectella* sp., Marshall),	Marshall.
B. North Sea.			
5. North Sea,	...	Lyssacine (*Euplectella* sp., Bowerbank),	Bowerbank.
C. Irish Channel.			
6. Irish Channel,	...	Lyssacine (*Hyalonema sieboldii* (?), Carter),	Carter.
D. North Atlantic.			
7. West of Norway,	1081	Lyssacine,	Armauer Hansen.
8. North of Shetland Islands,	550	*Hyalonema* (*Stylocalyx*) *thomsonii*, Marshall,	Marshall.
9. North of Scotland,	...	*Euplectella suberea*, Wyville Thomson,	Wyv. Thomson.
10. North of Hebrides,	...	*Hyalonema* sp., Wyv. Thomson,	Wyv. Thomson.
11. From Butt of Lewis to Gibraltar,	500–1000	*Pheronema* (*Holtenia*) *carpenteri*, Wyv. Thomson, and *Hyalonema* (*lusitanicum?*) Bocage, Wyv. Thomson,	Wyv. Thomson.
12. North West of Scotland,	327–430	*Asconema setubalense*, Sav. Kent,	John Murray.
13. Between Ireland and Færöe Island,	...	Lyssacine (*Euplectella* sp., Carter),	Carter.
14. West from English Channel,	..	*Aphrocallistes bocagei*, Wright,	Wyv. Thomson.
15. Coast of Spain and Portugal,	..	*Aphrocallistes bocagei*, Wright,	Wyv. Thomson.
16. Off Portugal,	..	*Euplectella* (*aspergillum?*), Owen,	Higgin and Wyv. Thomson.
,,	...	*Asconema setubalense*, Sav. Kent,	Saville Kent, Filhol.
,,	...	*Hyalonema lusitanicum*, Bocage,	Bocage, Sav. Kent.
,,	...	*Pheronema grayi*, Sav. Kent,	Sav. Kent.
,,	...	*Farrea* sp., and *Farrea* (*woodwardi?*), sp.,	Sav. Kent.
,,	..	*Fieldingia lagettoides*, Sav. Kent,	Sav. Kent.
17. Cape Verde Islands,	...	*Lanuginella pupa*, O. Schmidt,	O. Schmidt.
,,	...	*Aphrocallistes bocagei*, Wright,	O. Schmidt.
18. Florida,	98–123	*Sympagella nux*, O. Schmidt,	O. Schmidt.
,,	...	Lyssacine (*Holtenia pourtalesii*, O. Schmidt),	O. Schmidt.
,,	...	Lyssacine (*Holtenia saccus*, O. Schmidt),	O. Schmidt.
,,	...	Dictyonine (*Farrea facunda*, O. Schmidt),	O. Schmidt.
19. South-east of Florida,	...	*Aphrocallistes bocagei*, Wright,	O. Schmidt.
20. Cuba,	...	Dictyonine (*Farrea facunda*, O. Schmidt,)	O. Schmidt.
E. Gulf of Mexico and Caribbean Sea.			
21. Lat. 23° 2′ N., long. 83° 13′ W.,	287	Dictyonine (*Joanella compressa*, O. Schmidt),	O. Schmidt.
22. Lat. 23° 54′ N., long. 88° 55′ W.,	804	Dictyonine (*Rhabdostauridium retortula*, O. Schmidt),	O. Schmidt.
23. Lat. 25° 33′ N., long. 85° 21′ W.,	101	Dictyonine (*Scleroplegma herculeum*, O. Schmidt),	O. Schmidt.
24. Yukatan,	20 (?)	Dictyonine (*Cystispongia superstes*, O. Schmidt),	O. Schmidt.
25. North West of Havanna,	190	*Dactylocalyx subglobosus*, Gray,	O. Schmidt.
F. Antilles.			
26. Santa Cruz,	288	*Regadrella phœnix*, O. Schmidt,	O. Schmidt.
,,	...	*Pheronema annæ*, Leidy,	Leidy.
,,	...	,, ,,	O. Schmidt.
,,	218, 245	Dictyonine (*Syringidium zittelii*, O. Schmidt),	O. Schmidt.
,,	580	Dictyonine (*Pachaulidium* sp., O. Schmidt),	O. Schmidt.
,,	580	Dictyonine (*Scleroplegma herculeum*, O. Schmidt),	O. Schmidt.
27. Bequia,	1591	*Dictyocalyx gracilis*, F. E. Schulze,	O. Schmidt.
,,	1591	*Rhabdodictyum delicatum*, O. Schmidt,	O. Schmidt.
,,	1507	Lyssacine (*Liobolidium* sp., O. Schmidt),	O. Schmidt.
,,	1591	Dictyonine (*Cyathella lutea*, O. Schmidt),	O. Schmidt.
28. Guadeloupe,	583	*Hyalonema kentii*, O. Schmidt,	O. Schmidt.
,,	138, 150, 878	Dictyonine (*Syringidium zittelii*, O. Schmidt),	O. Schmidt.
,,	150	*Aulocystis zittelii*, Marshall,	O. Schmidt.
29. Dominica,	611	*Hertwigia falcifera*, O. Schmidt,	O. Schmidt.

TABLE II.—*continued.*

Locality.	Depth in Fathoms.	Species.	Authority.
30. Martinique,	565	*Hyalonema kentii*, O. Schmidt,	O. Schmidt.
,,	136	Dictyonine (*Syringidium zittelii*, O. Schmidt),	O. Schmidt.
31. St. Lucia,	416	*Euplectella joris*, O. Schmidt,	O. Schmidt.
,,	116	*Dactylocalyx subglobosus*, Gray,	O. Schmidt.
,,	116	Dictyonine (*Syringidium zittelii*, O. Schmidt),	O. Schmidt.
,,	151	Dictyonine (*Dactylocalyx potatorum*, O. Schmidt),	O. Schmidt.
32. St. Vincent,	...	*Cyrtaulon sigsbeei*, O. Schmidt,	O. Schmidt.
,,	...	*Dactylocalyx pumiceus*, Stutchbury,	O. Schmidt.
,,	...	*Aulocystis grayi*, Bowerbank,	Bowerbank.
33. Barbados,	221	*Regadrella phœnix*, O. Schmidt,	O. Schmidt.
,,	...	*Cyrtaulon sigsbeei*, O. Schmidt,	O. Schmidt.
,,	100	*Aulocystis zittelii*, Marshall,	O. Schmidt.
34. Grenada,	423	*Euplectella joris*, O. Schmidt,	O. Schmidt.
,,	291, 994	*Rhabdopectella tintinnus*, O. Schmidt,	O. Schmidt.
,,	338, 576	*Hyalonema kentii*, O. Schmidt,	O. Schmidt.
,,	416	Lyssacine (*Hyalonema* sp., O. Schmidt),	O. Schmidt.
35. Morrolight,	...	*Cyrtaulon sigsbeei*, O. Schmidt,	O. Schmidt.
,,	292	*Scleroplegma conicum*, O. Schmidt,	O. Schmidt.
,,	805	Dictyonine (*Diaretula cornu*, O. Schmidt),	O. Schmidt.
,,	805	Dictyonine (*Diaretula cornu*, O. Schmidt),	O. Schmidt.
36. Gulf of Mexico,	...	Dictyonine (*Farrea facunda*, O. Schmidt),	O. Schmidt.
,,	...	Dictyonine (*Scleroplegma lanterna*, O. Schmidt),	O. Schmidt.
37. Caribbean Sea,	...	Dictyonine (*Farrea infundibuliformis*, Carter),	Carter.
38. West Indies,	...	Dictyonine (*Farrea gassioti*, Bowerbank),	Bowerbank.
,,	...	Dictyonine (*Farrea pocillum*, Bowerbank),	Bowerbank.
,,	...	Dictyonine (*Farrea parasitica*, Bowerbank),	Bowerbank.
,,	...	Dictyonine (*Farrea perarmata*, Bowerbank),	Bowerbank.
		II.—INDIAN OCEAN.	
39. Seychelle Islands,	...	*Euplectella cucumer*, Owen,	Owen.
,,	...	Dictyonine (*Farrea occa*, Bowerbank),	Bowerbank.
,,	...	Dictyonine (*Farrea* sp., Bowerbank),	Bowerbank.
40. Mauritius,	...	*Habrodictyum speciosum*, Quoy and Gaimard,	Valenciennes.
		III.—PACIFIC OCEAN.	
41. Japan,	...	*Hyalonema sieboldii*, Gray,	Gray, Max Schultze, Hilgendorf.
,,	...	*Euplectella oweni*, Herkl. and Marshall,	Herkl. and Marshall.
42. Japan, Sagami Bay,	100–200	*Euplectella oweni*, ,, ,,	Döderlein.
,, ,,	,,	*Acanthascus cactus*, F. E. Schulze,	Döderlein.
,, ,,	,,	*Rhabdocalyptus mollis*, F. E. Schulze,	Döderlein.
,, ,,	,,	*Crateromorpha meyeri*, F. E. Schulze,	Döderlein.
,, ,,	,,	*Hyalonema sieboldii*, Gray	Carter, Döderlein, and others.
,, ,,	,,	*Farrea occa* (Bowerbank), Carter,	Carter, Döderlein.
,, ,,	,,	*Farrea sollasii*, F. E. Schulze,	Döderlein.
,, ,,	,,	*Eurete schmidtii*, F. E. Schulze,	Döderlein.
,, ,,	,,	*Eurete* sp.,	Döderlein.
,, ,,	,,	*Periphragella elisæ*, Marshall,	Carter, Döderlein.
,, ,,	,,	*Aphrocallistes bocagei*, Perceval Wright,	Döderlein.
,, ,,	,,	*Aphrocallistes ramosus*, F. E. Schulze,	Döderlein.
,, ,,	,,	*Aphrocallistes vastus*, F. E. Schulze,	Döderlein.
,, ,,	,,	*Chonelasma dœderleinii*, F. E. Schulze,	Doderlein.
,, ,,	,,	*Chonelasma calyx*, F. E. Schulze,	Döderlein.
,, ,,	,,	*Hexactinella ventilabrum*, Carter,	Carter, Gottsche, Döderlein.
43. Philippines,	...	*Euplectella aspergillum*, Owen,	Owen, Semper.
,,	...	*Semperella schultzei*, Semper,	Semper.
,,	...	*Eurete* sp. (*simplicissima*, Semper),	Semper.
,,	...	*Eurete farreopsis*, Carter,	Carter.
44. Zebu (Philippines),	...	*Euplectella aspergillum*, Owen,	Bowerbank, Gray, Moore, Chimmo and others.
,, ,,	...	*Semperella schultzei*, Semper,	Marshall and Meyer.
,, ,,	...	*Polylophus philippinensis*, Gray,	Gray, Marshall & Meyer.
,, ,,	...	*Crateromorpha meyeri*, Gray,	Gray.
,, ,,	...	*Hyalonema cebuense*, Higgin,	Higgin.

TABLE II.—*continued.*

Locality.	Depth in Fathoms.	Species.	Authority.
44. Zebu (Philippines),		*Pheronema hemisphæricum*, Gray,	Marshall and Meyer.
" "	...	*Sclerothamnus clausii*, Marshall,	Murie (Marshall).
" "		*Aulocystis zittelii*, Marshall,	Meyer and Marshall.
" "		*Eurete* sp.,	Meyer and Marshall.
45. Malacca,		*Dactylocalyx subglobosus*, Gray,	Gray.
46. Singapore,		*Pheronema hemisphæricum*, Gray,	Gray.
47. Moluccas,		*Habrodictyum speciosum*, Quoy and Gaimard,	Quoy and Gaimard.
"		*Periphragella elisæ*, Marshall,	Marshall.
IV.—ANTARCTIC OCEAN.			
48. Lat. 74° S., long. 175° W.,		*Rossella antarctica*, Carter,	Ross, Carter.

A glance at the map shows that there were four principal regions from which the considerable collection of Hexactinellida gathered before the Challenger Expedition had been obtained, viz.:—

1. West of Europe from the Shetland Islands to the Straits of Gibraltar.
2. Near the West India Islands, from Florida to Trinidad.
3. Near Japan, and especially in the Bays of Tokio and Sagami.
4. Near the Philippines, especially off the island of Zebu.

Besides these there are a few isolated localities in the North Sea and the Mediterranean, off the Cape Verde Islands, the Seychelles, Isle de Bourbon, Malacca, Moluccas, and in the Antarctic Ocean.

From these results it is obviously impossible to gain anything but an approximately plausible conception of the true distribution of the Hexactinellida. At the outset the fact has to be noted, that only in the four localities specially noted as the origin of the majority of the known forms and individuals, was the sea-bed satisfactorily examined below a depth of 100 fathoms. This was done on the Western European coasts by the dredgings of English and French expeditions, off the West India Islands by the explorations of Agassiz and Count Pourtalès, off the Philippines by the enterprising and successful activities of the fisher folk, and off Japan by a few naturalists and especially by Dr. Döderlein.

It is of course impossible to decide whether other localities noted in the Mediterranean, Indian Ocean, &c., represent the occurrence of Hexactinellida in altogether sporadic distribution, or the existence of a richly developed and perhaps widely distributed fauna, of which a few localities have been by chance discovered.

In regard to the distribution of the several suborders and families it is impossible for the same reason to glean many certain results. It is, however, worth noting in this connection that none of the localities are tenanted exclusively by any one family, but that all include representatives of different groups of the system.

GEOGRAPHICAL DISTRIBUTION OF THE CHALLENGER HEXACTINELLIDA.

After the above brief summary of the most important facts in regard to distribution known before, and independently of the Challenger Expedition, I may proceed to an account of the results which are now available.

I shall first give a tabular survey of all those stations of the Challenger Expedition at which Hexactinellida were obtained, including notes of the distribution in depth, the nature of the ground, and the number of specimens. The stations are arranged according to the route of the expedition, and I have also noted the distribution on the map accompanying this Report, in such a way that the marks indicate at least the great division, and as a rule the family to which the species in question belong.

TABLE III.—List of Hexactinellida collected during the Challenger Expedition, arranged according to Stations.

Station.	Locality.	Depth in Fathoms	Nature of Bottom.	Bottom Temperature F°.	Species.	No. of Specimens.
IV.	South-east of Cape St. Vincent,	600	Blue mud, . .	...	1. *Euplectella suberea*, Wyv. Thomson, . 2. *Hyalonema lusitanicum*, Barboza du Bocage,	1 1
V.	West of Gibraltar, . . .	1090	Globigerina ooze,	38·5	1. *Euplectella suberea*, Wyv. Thomson, .	1
3	South-west of Canary Islands,	1525	Hard ground, .	37·0	1. *Poliopogon amadou*, Wyv. Thomson, .	2
23	Off St. Thomas, West Indies, .	450	Pteropod ooze, .	...	1. *Aphrocallistes bocagei*, Perc. Wright, . 2. *Chonelasma* sp., ... 3. *Farrea* sp., ...	1 1 1
24	North of St. Thomas, West Indies,	390	Pteropod ooze, .	..	1. *Hyalonema toxeres*, Wyv. Thomson, . 2. *Farrea occa*, Carter, ... 3. *Aphrocallistes bocagei*, Perc. Wright, . 4. *Myliusia callocyathus*, Gray, . .	3 few 1 1
33	East of Bermudas, . . .	435	Coral mud, .	...	1. *Lefroyella decora*, Wyv. Thomson, .	2
56	South-west of Bermudas, .	1075	Coral mud, .	38·2	1. *Euplectella nodosa*, F. E. S., . . 2. *Rhabdodictyum delicatum*, F. E. S., . 3. *Aulocalyx irregularis*, F. E. S., . . 4. *Farrea* sp., ... 5. *Aphrocallistes bocagei*, Perc. Wright, 6. *Chonelasma* sp., ... 7. *Dactylocalyx patella*, F. E. S., . .	1 2 1 1 several 1 2
73	West of Azores, ...	1000	Pteropod ooze, .	39·4	1. *Hyalonema* (*Stylocalyx*) *thomsoni*, F. E. S.,	1
94	South of Cape Verde Islands,	1150	Volcanic mud, .	...	1. *Sympagella nux*, O. Schmidt, . .	1
124	East of Rio San Francisco, Brazil.	1600	Red mud, . .	...	1. *Euplectella suberea*, Wyv. Thomson, . 2. *Pheronema carpenteri*, Wyv. Thomson,	1 1

Table III.—*continued.*

Station.	Locality.	Depth in Fathoms	Nature of Bottom.	Bottom Temperature F°.	Species.	No. of Specimens.
135E	Off Tristan da Cunha, . .	1000	Hard ground, shells, gravel,	...	1. *Farrea* sp., ...	1
145	South-east of Prince Edward Island,	140	Volcanic sand, .	..	1. *Rossella antarctica*, Carter, . .	1
145A	South-east of Prince Edward Island,	310	Volcanic sand, .	..	1. *Aulascus johnstoni*, F. E. S., . . 2. *Aulocalyx irregularis*, F. E. S., . .	2 1
146	West of the Crozet Islands, .	1375	Globigerina ooze,	35·6	1. *Holascus fibulatus*, F. E. S., . . 2. *Malacosaccus vastus*, F. E. S., . .	1 1
147	West of the Crozet Islands, .	1600	Diatom ooze, .	34·2	1. *Holascus fibulatus*, F. E. S., . . 2. *Caulophacus latus*, F. E. S., . . 3. *Bathydorus spinosus*, F. E. S., . . 4. *Aulocalyx irregularis*, F. E. S., . . 5. *Hyalonema* (*Stylocalyx*) *clavigerum*, F. E. S., 6. *Farrea* sp., ...	1 2 1 1 1 1
148A	South of the Crozet Islands, .	550	Hard ground, gravel, shells.	.	1. *Acanthascus grossularia*, F. E. S., . 2. *Chonelasma lamella*, F. E. S., . . 3. *Hexactinella* sp., ...	1 2 1
149H	Off Kerguelen Island, . .	127	Volcanic mud, .	...	1. *Rossella antarctica*, Carter, . .	several
150	South of Kerguelen Island, .	150	Coarse gravel, .	35·2	1. *Rossella antarctica*, Carter,. . .	many
156	Lat. 62° 26′ S., long. 95° 44′ E., near Antarctic Circle,	1975	Diatom ooze, .	...	1. *Polyrhabdus oviformis*, F. E. S., .	1
157	Lat. 53° 55′ S., long. 108° 35′ E., Antarctic Ocean,	1950	Diatom ooze, .	32·1	1. *Holascus polejaëvii*, F. E. S., . . 2. *Balanites pipetta*, F. E. S., . . .	1 1
158	Lat. 50° 1′ S., long. 123° 4′ E.,	1800	Globigerina ooze,	33·5	1. *Hyalonema* (*Hyalonema*) *conus*, F.E.S.,	1
160	South-west of Melbourne, .	2600	Red clay, . .	33·9	1. *Holascus fibulatus*, F. E. S., . .	1
169	East of New Zealand, . .	700	Blue mud, . .	40·0	1. Hexactinellid (needles), . . .	...
170A	North-east of Kermadec Islands,	630	Volcanic mud, .	39·5	1. *Walteria flemmingii*, F. E. S., . . 2. *Euryplegma auriculare*, F. E. S., . 3. *Poliopogon gigas*, F. E. S., . . . 4. *Farrea occa*, Carter., ... 5. *Chonelasma lamella*, F. E. S., . . 6. *Chonelasma uncinatum*, F. E. S., .	1 2 1 1 2 1
171	North of Raoul Islands, .	600	Hard ground, .	39·5	1. *Aulochone cylindrica*, F. E. S., . .	1
174C	Off Fiji Islands, . . .	610	Coral mud, .	39·0	1. *Tægeria pulchra*, F. E. S., . . .	1
184	South-east of Cape York, Torres Strait,	1400	Globigerina ooze,	36·0	1. *Hyalonema* sp., ...	1
192	Off Little Ki Island, . .	140	Blue mud, . .	.	1. *Lanuginella pupa*, O. Schmidt., . 2. *Polylophus philippinensis*, Carter. . 3. *Crateromorpha thierfelderi*, F. E. S., . 4. *Crateromorpha murrayi*, F. E. S., . 5. *Pheronema giganteum*, F. E. S., . 6. *Pheronema globosum*, F. E. S., . . 7. *Semperella schultzei*, Semper, . . 8. *Eurete semperi*, F. E. S., . . . 9. *Eurete marshalli*, F. E. S., . . . 10. *Eurete carteri*, F. E. S., . . . 11. *Eurete farreopsis*, Carter, . . . 12. *Euretidæ*, ... 13. *Hexactinella lata*, F. E. S., . . . 14. *Cyrtaulon solutus*, F. E. S., . . 15. *Fieldingia lagettoides*, Sav. Kent. . 16. *Myliusia callocyathus*, Gray, . . 17. *Aulocystis zittelii*, Marshall, . . 18. Dictyoninæ, ...	few several 1 1 1 5 2 1 1 1 1 2 2 1 1 3 2 1

TABLE III.—*continued.*

Station.	Locality.	Depth in Fathoms	Nature of Bottom.	Bottom Temperature F°.	Species.	No. of Specimens.
194A	Off Banda Islands, . .	360	Volcanic mud, .	...	1. *Crateromorpha tumida*, . . . 2. *Hyalonema* (*Stylocalyx*) *globus*, F. E. S., 3. *Farrea clavigera*, F. E. S., . . 4. *Sclerothamnus clausii*, Marshall, . 5. *Myliusia callocyathus*, Gray, . . 6. *Aulocystis zittelii*, Marshall, . .	3 1 1 1 1 2
201	Off Samboangan, Mindanao, Philippines,	82	Stones, gravel, .	...	1. *Eurete schmidtii*, F. E. S., . .	2
205	West of Luzon, ...	1050	Blue mud, . .	37·0	1. *Hyalonema* sp., ...	1
207	Philippines, ...	700	Blue mud, . .	51·6	1. *Farrea occa*, Carter, ...	1
209	Philippines, Zebu, . . .	95–100	Blue mud, . .	71·0	1. *Euplectella aspergillum*, Owen, . . 2. *Polylophus phillippinensis*, Carter, . 3. *Crateromorpha meyeri*, Gray, . . 4. *Semperella schultzei*, Semper, . .	many several few 2
210	Philippines, ...	375	Blue mud, . .	54·1	1. *Aphrocallistes ramosus*, F. E. S., .	1
211	West of Mindanao, Philppines,	2225	Blue mud, . .	50·5	1. *Holascus ridleyi*, F. E. S., . . . 2. *Hyalonema gracile*, F. E. S., . .	1 1
214	South-east of Mindanao, Philippines,	500	Blue mud, .	41·8	1. *Aulochone lilium*, F. E. S., . .	1
232	Sagami Bay, Japan, . .	345	Green mud, .	41·1	1. *Hyalonema* (*Stylocalyx*) *apertum*, F. E. S.,	several
236	South of Japan, . . .	775	Green mud, .	37·6	1. Dictyonine, ...	1
241	East of Nipon, Japan, . .	2300	Red clay . .	35·1	1. *Caulophacus elegans*, F. E. S., . . 2. *Bathydorus fimbriatus*, F. E. S., . . 3. *Hyalonema robustum*, F. E. S., . . 4. *Hyalonema* sp., ...	3 1 1 1
246	Lat. 36° 10′ N., long. 178° 0′ E.,	2050	Globigerina ooze,	35·1	1. *Caulophacus* sp., ... 2. *Hyalonema* (*Stylocalyx*) *depressum*, F. E. S.,	1 several
248	Lat. 37° 41′ N., long. 177° 4′ W.,	2900	Red clay, .	35·1	1. *Bathydorus fimbriatus*, F. E. S., .	1
271	Lat. 0° 33′ S., long. 151° 34′ W.,	2425	Globigerina ooze,	35·0	1. *Hyalonema divergens*, F. E. S., . . 2. *Hyalonema* (*Stylocalyx*) *depressum*, F. E. S. 3. *Hyalonema* (*Stylocalyx*) *elegans*, F. E. S., 4. *Hyalonema* sp., ...	1 1 1 1
272	Lat. 3° 48′ S., long. 152° 56′ W.,	2600	Radiolarian ooze,	35·1	1. *Farreid* (?), ...	1
274	North-west of Caroline Islands,	2750	Radiolarian ooze,	35·1	1. *Euplectella crassistellata*, F. E. S., .	1
281	South of Tahiti, . . .	2385	Red clay . .	34·9	1. *Dictyocalyx gracilis*, F. E. S., . . 2. Dictyonine, ...	1 1
286	Lat. 33° 29′ S., long. 133° 22′ W.,	2335	Red clay, . .	34·8	1. *Bathydorus baculifer*, F. E. S., . . 2. Dictyonine, ...	3 1
289	Lat. 39° 41′ S., long. 131° 23′ W.,	2550	Red clay, . .	34·8	1. *Hyalostylus dives*, F. E. S., . . 2. *Trachycaulus gurlittii*, F. E. S., . . 3. *Hyalonema* (*Stylocalyx*) *elegans*, F. E. S.,	1 1 1
293	Lat. 39° 4′ S., long. 105° 5′ W.,	2025	Globigerina ooze,	34·4	1. Dictyonine, ...	1
300	Off Juan Fernandez, . .	1375	Globigerina ooze,	35·5	1. *Hyalonema poculum*, F. E. S., . .	1
307	Channel leading to the Magellan Strait,	140	Blue mud, .	...	1. *Bathydorus stellatus*, F. E. S., . .	1
310	Channel leading to the Magellan Strait,	400	Blue mud, .	46·5	1. *Acanthascus dubius*, F. E. S., . . 2. *Rhabdocalyptus rœperi*, F. E. S., .	1 1
320	South-east of Monte Video, .	600	Green sand, .	37·2	1. *Rossella antarctica*, Carter, . .	2

TABLE III.—*continued.*

Station.	Locality.	Depth in Fathoms	Nature of Bottom.	Bottom Temperature F°.	Species.	No. of Specimens.
323	East of Monte Video,	1900	Blue mud,	33·1	1. *Hyalonema tenue*, F. E. S.,	1
325	East of Monte Video,	2650	Blue mud,	32·7	1. *Holascus stellatus*, F. E. S.,	2
333	West of Tristan da Cunha,	2025	Globigerina ooze,	35·3	1. *Caulocalyx tener*, F. E. S., . 2. *Hyalonema* sp.,	1 1
343	South of Ascension,	425	Volcanic sand,	40·3	1. *Aphrocallistes bocagei*, Perc. Wright, 2. Dictyonine,	1 1
344	Off Ascension,	420	Volcanic sand,	...	1. *Aphrocallistes bocagei*, Perc. Wright,	1
348	Lat. 3° 10′ N., long. 14° 51′ W.	2450	Globigerina ooze,	...	1. *Malacosaccus unguiculatus*, F. E. S.,	1

A glance at the map shows that the Hexactinellida are by no means confined to the few localities hitherto chronicled. On the contrary they are widely distributed in all the oceans, and the majority of the Challenger specimens alone have not been found in localities where Hexactinellida were previously discovered, but in localities which are new for the group.

As the table shows, it was only at 58 of the 275 stations (*i.e.*, 21·1 per cent.) which were explored with dredge and trawl that Hexactinellida were obtained. And although these localities occur very uniformly over the whole route, nowhere is there any great interval between two successive localities. The greatest distance occurs between Stations 94 and 124, but it has to be noted that this portion of the return route, which included twelve stations where no Hexactinellida were found, was crossed at one point (Stations 102 and 348, lat. 3° 10′ N., long. 14° 51′ W.), where (Station 348) a Hexactinellid was discovered.

If we follow the course of the expedition, we see that in the first place to the west of the English channel (Stations IV., V.) some Hexactinellids were captured, and that afterwards, to the south-west of the Canary Islands (Station 3), the stately *Poliopogon amadou* was fished up. The booty became somewhat richer off the West India Island of St. Thomas, where, at the two Stations 23 and 24, six different species were procured. The next locality, off the Bermudas Islands (Stations 33 and 56), yielded in all eight species. West of the Azores, and afterwards off Cape Verde, two species were found. After a long pause two forms were captured off the coast of Brazil (east of the Rio San Francisco). On the tour from Bahia to the Cape of Good Hope, a fragment of a Hexactinellid was obtained near Tristan da Cunha, while near Prince Edward Island three different species rewarded the search. This last region seems indeed to have been tolerably rich in Hexactinellida, since some degrees further east first two, and soon afterwards six, different species, and off Crozets Islands, again three were obtained. Near

Kerguelen Island and 5° south of it there was an abundant occurrence of the large *Rossella antarctica*, while still further southwards, at Station 156, another Hexactinellid was found. At Station 157 (lat. 53° 55′ S., long. 108° 35′ E.) two forms were found, and 24° further east (Station 160) another, and again a fourth south-west of Melbourne. Neither on the south-east coast of Australia, nor on the voyage from Sydney to New Zealand, was there any sponge booty captured; but to the east of the North Island of New Zealand some Hexactinellid spicules at least were obtained, and near the Kermadec Islands as many as six different species. Near the Raoul Island was the habitat of the delicate *Aulochone cylindrica*, and off the Fiji Islands the beautiful *Tægeria* was trawled. After a break some *Hyalonema* fragments were again obtained to the south-east of the Torres Strait. The richest haul of Hexactinellida was obtained in the neighbourhood of the Little Ki Island, where no fewer than eighteen different species were found, some of them of large size and represented by several specimens; near the Banda Islands also six species were obtained, but after that it was not till the Philippines—long known as rich Hexactinellid localities—were reached that several forms rewarded the search. Of the seven different stations in the Philippine region, the locality between the islands of Zebu and Bohol, famous as the seat of the almost mercantile capture of *Euplectella aspergillum*, yielded not only numerous specimens of *Euplectella aspergillum*, but several of the well-known typically Philippine species, such as *Polylophus philippinensis*, *Crateromorpha meyeri*, and *Semperella schultzei*, while at the remaining six stations, only one, or at most two species were obtained. On the way from New Guinea to Japan no Hexactinellids were obtained, but in Japanese waters, in the Sagami Bay so industriously explored by Dr. Döderlein, one species of *Hyalonema* at least was found in great abundance. A Dictyonal form was also found to the south of the bay. Eight degrees east of Yokohama, at considerable depths, four remarkable forms were found, and again as many degrees further east some closely allied or identical species. On the long voyage from the Sandwich Islands to the equator no traces of Hexactinellids were discovered. On this side of the equator, however, at some adjacent localities near the line, as many as four different species of *Hyalonema* were trawled. After that two species were found some degrees south of Tahiti, and 8° to 10° to the south-east first two and then three forms. Again in the south-east portion of the Atlantic (Station 293) a fragment of a Dictyonal sponge was discovered; while near the island Juan Fernandez a *Hyalonema*, and at two stations in the Magellan Strait, first one and then two species were captured. On the return voyage through the Atlantic, the southern portion yielded no Hexactinellids, until several degrees to the east of Monte Video, at three distinct stations, the search was again successful. After that to the west of Tristan da Cunha and near Ascension Island single species were obtained, and lastly 3° north of the equator, at considerable depths, a single form belonging to the remarkable genus *Malacosaccus* was procured.

In regard to the number of species found at the different localities this general fact may be noted, that at most of the stations only one or two species were found, while only a few yielded several or many forms. The statistics on which I based this result in my preliminary communication[1] have been slightly altered by the additions of some localities, and by changes in the determination of a few species, but these modifications are on the whole unessential, and the results stand thus. Of the fifty-eight soundings on the occasion of which Hexactinellida were found—

34	yielded	only	1	species.
12	"	"	2	"
3	"	"	3	"
4	"	"	4	"
3	"	"	6	"
1	"	"	7	"
1	"	"	18	"

In his work La vie au fond des Mers, Filhol cites the statistics in question from my preliminary notice, and adds the following remark:—"Il résulte de ce tableau que dans plus de la moitié des cas les espèces d'Hexactinellides ont étè trouvées isolées. Cette observation ne concorde pas avec celles que nous avons pu faire dans la partie de l'Atlantique nord, parcourue avec le Talisman, où les chaluts n'ont rapporté qu' exceptionellement une seule espèce. Les Askonema ont été trouvées avec les Aphrocallistes; les Hyalonema, les Euplectelles étaient preque toujours associées." A possible solution of this apparent divergence in the results of two deep-sea expeditions, will be alluded to below when the general results as to the geographical distribution of the Hexactinellida are summed up.

The number of individuals of the same species found at one place is but rarely considerable. Generally only one or two specimens of each species were obtained at the same locality. Sometimes, however, a considerable number of specimens were found at once, as was the case with *Farrea occa* near St. Thomas, West Indies, *Aphrocallistes bocagei* off Bermudas, *Rossella antarctica* near the Kerguelen Islands, *Polylophus philippinensis* and *Pheronema globosum* at Little Ki Island, *Hyalonema depressum* in the middle of the North Pacific, and finally, *Crateromorpha meyeri*, *Polylophus philippinensis*, and especially *Euplectella aspergillum* at the Philippine Island, Zebu. Of the latter indeed, which was eagerly sought after, in a well-known locality, nearly a hundred specimens were obtained.

As to the richness of the different seas and regions in Hexactinellida, it is, in the first place, of interest to notice the absolute number of species found in the three great oceans. The following tables (IV. and V.) exhibit the state of the case in regard to this and similar points:—

[1] Narr. Chall. Exp., vol. i. part i. p. 449.

TABLE IV.—The Hexactinellida of the Challenger Collection,

LYSSACINA.

	ATLANTIC OCEAN.	SOUTH INDIAN OCEAN.	PACIFIC OCEAN.
I. Euplectellidæ. (15 Species).	1. *Euplectella suberea.* 2. *Euplectella nodosa.* 3. *Holascus stellatus.* 4. *Malacosaccus unguiculatus.* 5. *Rhabdodictyum delicatum.*	1. *Holascus fibulatus.* 2. *Holascus polejaëvii.* 3. *Malacosaccus vastus.*	1. *Euplectella aspergillum.* 2. *Euplectella crassistellata.* 3. *Holascus ridleyi.* 4. *Tægeria pulchra.* 5. *Walteria flemmingii.* 6. *Dictyocalyx gracilis.* 7. *Hyalostylus dives.*
II. Asconematidæ. (8 Species).	1. *Sympagella nux.*	1. *Aulascus johnstoni.* 2. *Polyrhabdus oviformis.* 3. *Balanites pipetta.* 4. *Caulophacus latus.*	1. *Caulophacus elegans.* 2. *Caulophacus* sp. 3. *Trachycaulus gurlitti.*
III. Rossellidæ. (19 Species).	1. *Rossella antarctica.* 2. *Caulocalyx tener.* 3. *Aulocalyx irregularis.*	1. *Rossella antarctica.* 2. *Acanthascus grossularia.* 3. *Bathydorus spinosus.* 4. *Aulocalyx irregularis.*	1. *Lanuginella pupa.* 2. *Polylophus philippinensis.* 3. *Acanthascus dubius.* 4. *Bathydorus fimbriatus.* 5. *Bathydorus stellatus.* 6. *Bathydorus baculifer.* 7. *Rhabdocalyptus rœperi.* 8. *Crateromorpha meyeri.* 9. *Crateromorpha thierfelderi.* 10. *Crateromorpha murrayi.* 11. *Crateromorpha tumida.* 12. *Aulochone cylindrica.* 13. *Aulochone lilium.* 14. *Euryplegma auriculare.*
IV. Hyalonematidæ. (21 Species).	1. *Hyalonema toxeres.* 2. *Hyalonema* (*Stylocalyx*) *thomsoni.* 3. *Hyalonema lusitanicum.* 4. *Hyalonema tenue.* 5. *Hyalonema* sp. 6. *Pheronema carpenteri.* 7. *Poliopogon amadou.*	1. *Hyalonema conus.* 2. *Hyalonema* (*Stylocalyx*) *clavigerum.*	1. *Hyalonema gracile.* 2. *Hyalonema divergens.* 3. *Hyalonema poculum.* 4. *Hyalonema* (*Stylocalyx*) *apertum.* 5. *Hyalonema* (*Stylocalyx*) *depressum.* 6. *Hyalonema* (*Stylocalyx*) *globus.* 7. *Hyalonema* (*Stylocalyx*) *elegans.* 8. *Hyalonema robustum.* 9. *Hyalonema* sp. 10. *Pheronema globosum.* 11. *Pheronema giganteum.* 12. *Poliopogon gigas.* 13. *Semperella schultzei.*
Species of Lyssacina,	16	13	37

ARRANGED ACCORDING TO THE OCEANS WHENCE THEY WERE OBTAINED.

DICTYONINA.

	ATLANTIC OCEAN.	SOUTH INDIAN OCEAN.	PACIFIC OCEAN.
V. FARREIDÆ. (4 Species).	1. *Farrea occa.* 2. *Farrea* sp.	1. *Farrea* sp.	1. *Farrea occa.* 2. *Farrea clavigera.* 3. Farreid.
VI. EURETIDÆ. (6 Species).	1. *Lefroyella decora.*		1. *Eurete semperi.* 2. *Eurete schmidtii.* 3. *Eurete farreopsis.* 4. *Eurete carteri.* 5. *Eurete marshalli.* 6. Euretid.
VII. MELITTIONIDÆ. (2 Species).	1. *Aphrocallistes bocagei.*		1. *Aphrocallistes ramosus.*
VIII. COSCINOPORIDÆ. (3 Species).	1. *Chonelasma* sp.	1. *Chonelasma lamella.*	1. *Chonelasma lamella.* 2. *Chonelasma hamatum*
IX. TRETODICTYIDÆ. (5 Species).		1. *Hexactinella* sp.	1. *Hexactinella lata.* 2. *Cyrtaulon solutus.* 3. *Fieldingia lagettoides.* 4. *Sclerothamnus clausii.*
X. MÆANDROSPONGIDÆ. (3 Species).	1. *Dactylocalyx patella.* 2. *Myliusia callocyathus.* 1. Dictyonine.		1. *Myliusia callocyathus.* 2. *Aulocystis zittelii.* 1. Dictyonine.
Species of Dictyonina,	8	3	19
			1. Hexactinellid
Species of Hexactinellida,	24	16	57

TABLE V.—The Hexactinellida of the Challenger Collection, arranged

List of all the Species in the Challenger Collection.			North Atlantic Ocean.		South Atlantic Ocean.	
	Species.	Station.	Species.	Station.	Species.	Station.
I. Euplectellidæ.	1. *Euplectella aspergillum*, Owen, .	209				
	2. *Euplectella suberea*, Wyv., Thomson, ...	IV., V., 124	1. *Euplectella suberea*,	IV., V.	1. *Euplectella suberea*,	124
	3. *Euplectella crassistellata*, F. E. Schulze, ...	274				
	4. *Euplectella* (?) *nodosa*, F. E. Schulze, ...	56	2. *Euplectella nodosa*,	56		
	5. *Holascus stellatus*, F. E. Schulze,	325			2. *Holascus stellatus*, .	325
	6. *Holascus fibulatus*, F. E. Schulze	146, 147, 160				
	7. *Holascus polejaëvii*, F. E. Schulze,	157				
	8. *Holascus ridleyi*, F. E. Schulze,	211				
	9. *Malacosaccus vastus*, F. E. Schulze,	146				
	10. *Malacosaccus unguiculatus*, F. E. Schulze, ...	348	3. *Malacosaccus unguiculatus*, . .	348		
	11. *Tægeria pulchra*, F. E. Schulze, .	174c				
	12. *Walteria flemmingii*, F. E. Schulze, ...	170a				
	13. *Dictyocalyx gracilis*, F. E. Schulze,	281				
	14. *Rhabdodictyum delicatum*, O. Schmidt, ...	56	4. *Rhabdodictyum delicatum*, . .	56		
	15. *Hyalostylus dives*, F. E. Schulze,	289				
II. Asconematidæ.	16. *Aulascus johnstoni*, F. E. Schulze,	145a				
	17. *Sympagella nux*, O. Schmidt, .	94	5. *Sympagella nux*, .	94		
	18. *Polyrhabdus oviformis*, F. E. Schulze, ...	156				
	19. *Balanites pipetta*, F. E. Schulze,	157				
	20. *Caulophacus latus*, E. F. Schulze,	147				
	21. *Caulophacus elegans*, F. E. Schulze,	241				
	22. *Caulophacus* sp., ...	246				
	23. *Trachycaulus gurlittii*, F. E. Schulze, ...	289				
III. Rossellidæ.	24. *Lanuginella pupa*, O. Schmidt, .	192				
	25. *Polylophus philippinensis*, Gray, .	209				
	26. *Rossella antarctica*, Carter, . .	145, 150, 169h, 320			3. *Rossella antarctica*,	320
	27. *Acanthascus grossularia*, F. E. Schulze, ...	148				
	28. *Acanthascus dubius*, F. E. Schulze,	310				
	29. *Bathydorus fimbriatus*, F. E. Schulze, ...	241, 248				
	30. *Bathydorus stellatus*, F. E. Schulze,	307				
	31. *Bathydorus spinosus*, F. E. Schulze,	147				
	32. *Bathydorus baculifer*, F. E. Schulze, ...	286				
	33. *Rhabdocalyptus roeperi*, F. E. Schulze, ...	310				
	34. *Crateromorpha meyeri*, Gray, .	209				
	35. *Crateromorpha thierfelderi*, F. E. Schulze, ...	192				
	36. *Crateromorpha murrayi*, F. E. Schulze, ...	192				
	37. *Crateromorpha tumida*, F. E. Schulze, ...	194				
	38. *Aulochone cylindrica*, F. E. Schulze, ...	171				
	39. *Aulochone lilium*, F. E. Schulze,	214				
	40. *Caulocalyx tener*, F. E. Schulze, .	333			4. *Caulocalyx tener*, .	333
	41. *Aulocalyx irregularis*, F. E. Schulze, ...	56, 145a	6. *Aulocalyx irregularis*, . . .	56		
	42. *Euruplegma auriculare*, F. E. Schulze, ...	170a				

ACCORDING TO THE FIVE PRINCIPAL MARINE DISTRIBUTIONAL AREAS.

SOUTH INDIAN OCEAN.		NORTH PACIFIC OCEAN.		SOUTH PACIFIC OCEAN.	
Species.	Station.	Species.	Station.	Species.	Station.
		1. *Euplectella aspergillum*,	209		
				1. *Euplectella crassistellata*,	274
1. *Holascus fibulatus*,	146, 147, 160				
2. *Holascus polejaëvii*,	157				
		2. *Holascus ridleyi*,	211		
3. *Malacosaccus vastus*,	146				
				2. *Tægeria pulchra*,	174C
				3. *Walteria flemmingii*,	170A
				4. *Dictyocalyx gracilis*,	281
				5. *Hyalostylus dives*,	289
4. *Aulascus johnstoni*,	145A				
5. *Polyrhabdus oviformis*,	156				
6. *Balanites pipetta*,	157				
7. *Caulophacus latus*,	147				
		3. *Caulophacus elegans*,	241		
		4. *Caulophacus* sp.,	246	6. *Trachycaulus gurlittii*,	289
				7. *Lanuginella pupa*,	192
		5. *Polylophus philippinensis*,	209	8. *Polylophus philippinensis*,	192
8. *Rossella antarctica*,	145, 149H, 150				
9. *Acanthascus grossularia*	148				
				9. *Acanthascus dubius*,	310
		6. *Bathydorus fimbriatus*,	241		
				10. *Bathydorus stellatus*,	307
10. *Bathydorus spinosus*,	147				
				11. *Bathydorus baculifer*,	286
				12. *Rhabdocalyptus roeperi*,	310
		7. *Crateromorpha meyeri*,	209	13. *Crateromorpha thierfelderi*,	192
				14. *Crateromorpha murrayi*,	192
				15. *Crateromorpha tumida*,	194A
				16. *Aulochone cylindrica*,	171
		8. *Aulochone lilium*,	214		
11. *Aulocalyx irregularis*,	145A				
				17. *Euryplegma auriculare*,	170A

TABLE V.—*continued.*

List of all the Species in the Challenger Collection.			North Atlantic Ocean.		South Atlantic Ocean.	
	Species.	Station.	Species.	Station.	Species.	Station.
IV. Hyalonematidæ.	43. *Hyalonema gracile*, F. E. Schulze,	211				
	44. *Hyalonema divergens*, F. E. Schulze, ...	271				
	45. *Hyalonema toxeres*, Wyv. Thomson, ...	24	7. *Hyalonema toxeres*,	24		
	46. *Hyalonema poculum*, F. E. Schulze,	300				
	47. *Hyalonema conus*, F. E. Schulze,	158				
	48. *Stylocalyx thomsoni*, Marshall, .	73	8. *Stylocalyx thomsoni*,	73		
	49. *Stylocalyx apertus*, F. E. Schulze,	232				
	50. *Stylocalyx depressus*, F. E. Schulze,	246				
	51. *Stylocalyx claviger*, F. E. Schulze,	147				
	52. *Stylocalyx globus*, F. E. Schulze, .	194A				
	53. *Stylocalyx elegans*, F. E. Schulze,	271				
	54. *Stylocalyx tener*, F. E. Schulze, .	289				
	55. *Hyalonema lusitanicum*, Barb. de Bocage, ...	IV.	9. *Hyalonema lusitanicum*, . . .	IV.		
	56. *Hyalonema tenue*, F. E. Schulze, .	323			5. *Hyalonema tenue*, .	323
	57. *Hyalonema robustum*, F. E. Schulze, ...	241				
	58. *Hyalonema* sp., ...	184, 205, 271, 333			6. *Hyalonema* sp., .	333
	59. *Pheronema carpenteri*, Wyv. Thomson, ...	124			7. *Pheronema carpenteri*, . .	124
	60. *Pheronema globosum*, F. E. Schulze, ...	192				
	61. *Pheronema giganteum*, F. E. Schulze, ...	192				
	62. *Poliopogon amadou*, Wyv. Thomson, ...	3	10. *Poliopogon amadou*,	3		
	63. *Poliopogon gigas*, F. E. Schulze, .	170A				
	64. *Semperella schultzei*, Semper, .	209				
V. Farreidæ.	65. *Farrea occa*, Carter, ...	24, 217, 292	11. *Farrea occa*, . .	24		
	66. *Farrea clavigera*, F. E. Schulze, .	194A,				
	67. *Farrea* sp., ...	23, 56, 135E, 147	12. *Farrea* sp., . .	23, 56	8. *Farrea* sp., . .	135E
	68. Farreid, ...	272				
VI. Euretidæ.	69. *Eurete semperi*, F. E. Schulze, .	192				
	70. *Eurete schmidtii*, F. E. Schulze, .	201				
	71. *Eurete farreopsis*, Carter, . .	192				
	72. *Eurete carteri*, F. E. Schulze, .	192				
	73. *Eurete marshalli*, F. E. Schulze, .	192				
	74. *Lefroyella decora*, Wyv. Thomson,	33, 56	13. *Lefroyella decora*, .	33		
VII. Melittionidæ.	75. Euretid, ...	192				
	76. *Aphrocallistes bocagei*, Perceval Wright, ...	343, 23, 24, 56, 344	14. *Aphrocallistes bocagei*, . . .	23, 24, 56	9. *Aphrocallistes bocagei*, . . .	343
	77. *Aphrocallistes ramosus*, F. E. Schulze, ...	210				
VIII. Coscinoporidæ.	78. *Chonelasma lamella*, F. E. Schulze,	148A, 170A				
	79. *Chonelasma hamatum*, F. E. Schulze, ...	170A				
	80. *Chonelasma* sp., ...	23, 56, 143A	15. *Chonelasma* sp., .	23, 56		
IX. Tretodictyidæ.	81. *Hexactinella lata*, F. E. Schulze,	192				
	82. *Hexactinella* sp., ...	148A				
	83. *Cyrtaulon solutus*, F. E. Schulze,	192				
	84. *Fieldingia lagettoides*, Sav. Kent,	192				
	85. *Sclerothamnus clausii*, Marshall, .	144A				
X. Mæandrospongidæ.	86. *Dactylocalyx patella*, F. E. Schulze, ...	56	16. *Dactylocalyx patella*,	56		
	87. *Myliusia callocyathus*, Gray, .	24, 192, 194A	17. *Myliusia callocyathus*, . .	24		
	88. *Aulocystis zittelii*, Marshall, . .	192, 194A				
	89. Dictyonine, ...	236, 343			10. Dictyonine, . .	343
	90. Hexactinellid, ...	169				

TABLE V.—*continued.*

SOUTH INDIAN OCEAN.		NORTH PACIFIC OCEAN.		SOUTH PACIFIC OCEAN.	
Species.	Station.	Species.	Station.	Species.	Station.
		9. *Hyalonema gracile*, . .	211	18. *Hyalonema divergens*, . .	271
				19. *Hyalonema poculum*, . .	300
12. *Hyalonema conus*, . .	158				
		10. *Stylocalyx apertus*, . .	232		
		11. *Stylocalyx depressus*, . .	246	20. *Stylocalyx depressus*, . .	271
13. *Stylocalyx claviger*, . .	147				
				21. *Stylocalyx globus*, . . .	194A
				22. *Stylocalyx elegans*, . .	271
		12. *Hyalonema robustum*, .	241		
		13. *Hyalonema* sp., . . .	205, 241	23. *Hyalonema* sp., . . .	184, 271
				24. *Pheronema globosum*, . .	192
				25. *Pheronema giganteum*, .	192
				26. *Poliopogon gigas*, . . .	170A
		14. *Semperella schultzei*, . .	209	27. *Semperella schultzei*, . .	325
		15. *Farrea occa*, . . .	207	28. *Farrea occa*, . . .	293
				29. *Farrea clavigera*, . . .	194A
14. *Farrea* sp., ...	147				
				30. Farreid, ...	272
				31. *Eurete semperi*, . . .	192
		16. *Eurete schmidtii*, . .	201		
				32. *Eurete farreopsis*, . .	192
				33. *Eurete carteri*, . . .	192
				34. *Eurete marshalli*, . .	192
				35. Euretid, ...	192
		17. *Aphrocallistes ramosus*, .	210		
15. *Chonelasma lamella*, . .	148A			36. *Chonelasma lamella*, . .	170A
				37. *Chonelasma hamatum*, .	170A
				38. *Hexactinella lata*, . .	192
16. *Hexactinella* sp., . .	148A				
				39. *Cyrtaulon solutus*, . .	192
				40. *Fieldingia lagettoides*, . .	192
				41. *Myliusia callocyathus*, .	192
				42. *Aulocystis zittelii*, . .	192
		18. Dictyonine, ...	236	43. Dictyonine, ...	293, 286, 192, 281,
				44. Hexactinellid, . . .	169

Of the ninety different species of Hexactinellids obtained on the Challenger Expedition—

24 species were found in the Atlantic.
16 " " Indian Ocean.
57 " " Pacific.

But it is obvious that these figures taken by themselves, without reference to the number of dredgings and trawlings, do not give any correct representation of the abundance of Hexactinellida in the different regions. It is necessary to take into account for each ocean the total number of dredgings or trawlings, and the proportion of these which yield Hexactinellida. The percentage figures for the separate regions must then be compared with the statistics of the whole expedition.

Out of the total 276 dredgings or trawlings only 58 yielded Hexactinellida, which gives a percentage of 21·1 over the whole. Of the 125 dredgings or trawlings in the Atlantic 19 yielded Hexactinellida, *i.e.*, a percentage of 15·2; of the 32 searches in the Indian Ocean 11 were successful, *i.e.*, 34·4 per cent.; of the 119 in the Pacific 28, *i.e.*, 23·5 per cent., were rewarded with Hexactinellid booty.

Thus we see that of the three oceans the Atlantic appears to be by far the poorest in Hexactinellids, and in its percentage of 15·2 is not a little below the general average of 21·1; while in contrast to this the Indian Ocean is richest, and in its percentage of 34·4 is considerable above the average, which the Pacific with its 23·5 per cent. only slightly exceeds.

If in the case of the two largest oceans the northern be estimated apart from the southern half, then the proportionate statistics stands as follows:—

	North Atlantic.	South Atlantic.	Southern Ocean.	North Pacific.	South Pacific.
Total number of dredgings or trawlings.	79	46	32	47	72
	125			119	
Number of dredgings or trawlings yielding Hexactinellids.	11	8	11	11	17
	19			28	
Percentages of the dredgings or trawlings yielding Hexactinellids compared with the total numbers of dredgings or trawlings.	13·9	17·4	34·4	23·4	23·6
	15·2			23·5	

From this it is apparent that the northern portion of the Atlantic is not so rich in Hexactinellids as the southern, and that in the Pacific also the northern half is somewhat surpassed by the southern.

Furthermore, it must be carefully noted that this computation takes into account only the localities, but neither the number of the discovered species nor the abundance of specimens. When the number of species are also computed the proportions stand as follows :—

	North Atlantic.	South Atlantic.	Indian Ocean.	North Pacific.	South Pacific.
Number of dredgings or trawlings—in all 276.	79	46	32	47	72
	125			119	
Number of species of Hexactinellida—in all 89.	17	10	16	18	44
	24			56	
Percentages of species in relation to the number of dredgings or trawlings—on an average 32·4.	21·5	21·7	50	38·3	61·1
	19·1			47·1	

The total number of Hexactinellid species found at the 276 Stations explored with dredge or trawl is 89, *i.e.*, 32·4 per cent. At the 125 localities explored in the Atlantic, 24 different Hexactinellid species were found, *i.e.*, 19·1 per cent.,—and of these 17 were got from the 79 dredgings or trawlings in the North Atlantic, *i.e.*, 21·5 per cent., while in the South Atlantic 46 searches yielded 10 species, *i.e.*, 21·7 per cent. The 32 dredgings or trawlings in the Indian Ocean yielded 16 different species = 50 per cent. In the Pacific the 119 localities explored by dredge and trawl yielded a total of 56 species, or 47·1 per cent., and of these 18 species or 38·3 per cent. were found at the 47 dredgings or trawlings in the northern, and 44 species or 61·1 per cent. in the 72 searches in the southern region.

It is evident that the percentage expression of the abundance of Hexactinellids is quite altered when we consider the number of species as well as the localities of capture, though the relative proportion for the different oceans, or northern and southern regions, is but slightly changed. On this computation the Atlantic, and especially the North Atlantic, is seen to be poorest in Hexactinellids, while the Indian Ocean is richest. Only the southern half of the Pacific appears considerably richer than in the previous table, in fact even richer than the Indian Ocean. The proportionate richness thus stands as follows :—

North Atlantic.	South Atlantic.	North Pacific.	Indian Ocean.	South Pacific.
21·5 per cent.	21·7 per cent.	38·3 per cent.	50 per cent.	61·1 per cent.

The richest localities on the Challenger Expedition were in the Atlantic at the West Indian Island of St. Thomas and at the Bermudas, in the South Indian Ocean in the region

between the Prince Edward and Crozet Islands, in the Pacific off the Kermadec, Little Ki, and Philippine Islands.

In the middle of the oceans, as well as near the continents, Hexactinellids were indeed found, but generally speaking the abundance of species was less at a distance from the mainland, and in the middle of the great ocean basins, than in the neighbourhood of the continents or island groups.

It is necessary now to pass to the more detailed distribution of the individual groups in the various seas.

In the Atlantic 16 species of Lyssacina were found, in the Indian Ocean 11, and 37 in the Pacific.

If we consider again the number of localities at which dredging and trawling explorations were undertaken, we have the following results :—

For the	125	dredgings or trawlings in the	Atlantic,	16	species of Lyssacina,	= 12·9	per cent.
,,	32	,, ,,	Indian Ocean,	11	,, ,,	34·4	,,
,,	119	,, ,,	Pacific,	37	,, ,,	31·0	,,

As to Dictyonina, the Atlantic yielded 8, the Indian Ocean 3, and the Pacific 18 species. And in reference to the number of dredgings and trawlings in the same sea, these figures represent for the Atlantic 6·4 per cent., for the Indian Ocean 9·4 per cent., and 15·1 per cent. for the Pacific.

In regard to the separate families of Lyssacina, the Atlantic yielded 5 species of Euplectellidæ, the Indian Ocean 3, and the Pacific 5, that is to say, in reference to the number of dredgings and trawlings, 4 per cent. for the Atlantic, 9·4 per cent. for the Indian Ocean, and 6 per cent. for the Pacific. And here it should be noted further that the three species of Euplectellidæ found in the Indian Ocean belonged to the genera *Holascus* and *Malacosaccus, i.e.*, to the subfamily Holascinæ, while in the Atlantic and Pacific representatives of all the three subfamilies were discovered. Of Asconematidæ the Atlantic yielded only 1 species, while in the Indian Ocean 4, and in the Pacific 3 were found. A reference to the relatively small number of dredgings and trawlings undertaken in the Indian Ocean, proves a special abundance of Asconematidæ in this last region.

The Atlantic yielded 3 species of Rossellidæ, the Indian Ocean 4, and the Pacific 14 species, which mostly belonged to the Crateromorphinæ.

In the Atlantic 7 Hyalonematidæ were found, in the Indian Ocean 2, and in the Pacific 13 species.

In reference to the Dictyonina, if we take all the Uncinataria together in consideration of the small number of representatives of the separate families, we find that the Atlantic yielded 5, the Indian Ocean 3, and the Pacific 15 species, that is, in reference to the number of dredgings and trawlings, 4 per cent. for the Atlantic, 9·4 for the Indian Ocean, and 12·6 for the Pacific. In a comparative survey of the separate

genera within this group it is striking that in the Pacific alone 5 species of *Eurete* were found, while this genus did not occur once in the other two oceans.

Mæandrospongidæ were represented only in the Atlantic and Pacific, in each by 2 species.

Further details as to the separate genera and species yield the following results. The genus *Euplectella* was found in the Atlantic and Pacific, but *not* in the Indian Ocean. The beautiful *Euplectella aspergillum* was only obtained at the one familiar locality, namely, at the Philippine Island, Zebu. *Euplectella crassistellata* was also found in the Pacific, but at a great distance from the mainland. *Euplectella suberea* and *Euplectella nodosa* appear to be restricted to the Atlantic.

In each of the three oceans one or two representatives of the genus *Holascus* were discovered. *Malacosaccus* was found at one locality in the Atlantic, and in the Indian Ocean. The two Tægerinæ occur in the Pacific; *Tægeria pulchra* near the Fiji Islands, and *Walteria flemmingii* off Kermadec.

Of Asconematidæ, only one species, namely, *Sympagella nux*, was found in the Atlantic, near the Cape Verde Islands; four species in the Indian Ocean, viz., *Polyrhabdus oviformis, Aulascus johnstoni, Balanites pipetta,* and *Caulophacus latus,* and two in the Pacific, namely, *Caulophacus elegans* to the east of Yokohama, and the peculiar *Trachycaulus gurlittii* in the middle of the South Pacific.

While the Rossellidæ were represented in the Atlantic region only by the small *Lanuginella pupa,* found off Little Ki Island, and by *Polylophus philippinensis,* near the Philippine Island, Zebu, *Rossella antarctica* was found both in the South Pacific and in several regions in the South Indian Ocean, and in especial abundance near Kerguelen. Of the genus *Acanthascus,* one species, *Acanthascus grossularia,* was found in the Indian Ocean, the other, *Acanthascus dubius,* in the Pacific portion of the Magellan Strait. The species of *Bathydorus* are similarly distributed in the same two oceans, *Bathydorus spinosus* occurred in the Indian Ocean, near the Crozet Islands; *Bathydorus fimbriatus, Bathydorus baculifer,* and *Bathydorus stellatus,* in the Pacific, the first in the North Pacific at two localities, *Bathydorus baculifer* in the middle of the South Pacific, and *Bathydorus stellatus* in the Magellan Strait, where *Rhabdocalyptus ræperi* also occurred. All the four Challenger species of *Crateromorpha* were found in the Pacific, *Crateromorpha meyeri* from the neighbourhood of the Philippine Island, Zebu, *Crateromorpha thierfelderi* and *Crateromorpha murrayi* off Little Ki Island, and *Crateromorpha tumida* off one of the Banda Islands. The species of *Aulochone* were also obtained in the Pacific, *Aulochone cylindrica* from the Kermadec Islands, and *Aulochone lilium* from the Philippines. On the other hand, *Caulocalyx tener* was found in the middle of the South Atlantic, and *Aulocalyx irregularis* both in the Atlantic near the Bermudas, and in two localities in the South Indian Ocean, namely, near Prince Edward Island and off the Crozets. Finally, the Dictyonal-like *Euryplegma auriculare* was found in the Pacific near the Kermadec Islands.

Of the numerous species of *Hyalonema* no one form was represented in two oceans. In the Atlantic *Hyalonema toxeres* was found near St. Thomas, *Hyalonema* (*Stylocalyx*) *thomsoni* west of the Azores, *Hyalonema lusitanicum* to the south-west of Portugal and west of the Straits of Gibraltar, as also at an undefined locality in the middle of the South Atlantic. The two species of *Hyalonema* found in the South Indian Ocean were *Hyalonema conus* to the south-west of Australia, and *Hyalonema* (*Stylocalyx*) *clavigerum* to the west of the Crozets Islands.

Of the species of *Pheronema* the Challenger found *Pheronema carpenteri* in the Atlantic to the north-east of Bahia, and *Pheronema globosum* and *Pheronema giganteum* in the Pacific, off Little Ki Island in the Malay Archipelago. *Poliopogon amadou* occurred in the Atlantic, south-west of the Canary Islands, and *Poliopogon gigas* in the Pacific, between the Raoul and Kermadec Islands. *Semperella schultzei* finally was obtained both at the well-known locality near the Philippine Island, Zebu, and also in the Malayan Archipelago off Little Ki Island.

As to the Farreidæ, *Farrea occa* occurred both in the Atlantic off the island of St. Thomas, and also in the Pacific at the Philippine and off the Kermadec Islands, while *Farrea clavigera* was only found in the Pacific near the Banda Islands. Undefined species of this remarkable, and apparently widely distributed genus, were found in all the three oceans at various localities.

Five species of *Eurete* were found in the Pacific, four of them off Little Ki Island and one at the Philippines, but in the Indian Ocean no Euretid was found, and in the Atlantic only the single species *Lefroyella decora* off the Bermudas. *Aphrocallistes bocagei* occurred at several localities in the Atlantic, *Aphrocallistes ramosus* only in the Pacific at the Philippines. *Chonelasma* was represented in all the three oceans, by *Chonelasma lamella* both in the South Indian Ocean (near the Crozets Islands) and in the Pacific (off Kermadec), by *Chonelasma hamatum* only in the Pacific at the last named locality. Some undefined fragments of *Chonelasma* occurred at different localities in the Atlantic.

Of Tretodictyidæ the Challenger found in the Pacific *Hexactinella lata*, *Cyrtaulon solutus*, *Fieldingia lagettoides*, and *Sclerothamnus clausii*, all near the Little Ki Island, and in the South Indian Ocean an undefined *Hexactinella* fragment near the Crozets.

The Mæandrospongidæ found in the Atlantic were *Dactylocalyx patella* off the Bermudas, and near the Spanish Coast, and *Myliusia callocyathus* off the West India Island of St. Thomas. The Pacific yielded *Myliusia callocyathus* off Little Ki Island and near the Bandas, and likewise *Aulocystis zittelii*.

In regard to the proportionate richness of the two temperate and the tropical zones, it is necessary first of all to note the absolute number of localities yielding Hexactinellida in these three regions. The number of species in each zone must then be noted as in the following tables (VI., VII.), and these statistics collated with the total number of dredgings and trawlings in the respective regions.

TABLE VI.—Distribution of the Hexactinellida of the Challenger Collection in the different Zones.

	North Temperate Zone.	Station.	Tropical Zone.	Station.	South Temperate Zone.	Station.
LYSSACINA—						
I. Euplectellidæ. (15 Species).	1. *Euplectella suberea*, 2. *Euplectella nodosa*, 3. *Rhabdodictyum delicatum*,	IV., V. 56 56	1. *Euplectella aspergillum*, 2. *Euplectella suberea*, 3. *Euplectella crassistellata*, 4. *Holascus ridleyi*, 5. *Malacosaccus unguiculatus*, 6. *Tageria pulchra*, 7. *Dictyocalyx gracilis*,	209 124 274 211 348 174C 281	1. *Holascus stellatus*, 2. *Holascus fibulatus*, 3. *Halascus polejaëvii*, 4. *Malacosaccus vastus*, 5. *Walteria flemmingii*, 6. *Hyalostylus dives*,	325 204A, 160 157 146 170A 289
II. Asconematidæ. (8 Species).	1. *Caulophacus elegans*, 2. *Caulophacus* sp.,	246 246	1. *Sympagella nux*,	94	1. *Aulascus johnstoni*, 2. *Polyrhabdus oviformis*, 3. *Balanites pipetta*, 4. *Caulophacus latus*, 5. *Trachycaulus gurlitti*,	145A 156 157 146 286
III. Rossellidæ. (19 Species).	1. *Bathydorus fimbriatus*, 2. *Aulocalyx irregularis*,	248, 241 56	1. *Lanuginella pupa*, 2. *Polylophus philippinensis*, 3. *Crateromorpha meyeri*, 4. *Crateromorpha thierfelderi*, 5. *Crateromorpha murrayi*, 6. *Crateromorpha tumida*, 7. *Aulochone lilium*,	192 192 209 192 192 194A 214	1. *Rossella antarctica*, 2. *Acanthascus grossularia*, 3. *Acanthascus dubius*, 4. *Bathydorus stellatus*, 5. *Bathydorus spinosus*, 6. *Bathydorus baculifer*, 7. *Rhabdocalyptus roperi*, 8. *Aulochone cylindrica*, 9. *Aulocalyx irregularis*, 10. *Caulocalyx tener*, 11. *Euryplegma auriculare*,	145, 149H, 150, 320 148A 310 307 147 286 318 171 145A, 147 133 170A
IV. Hyalonematidæ. (21 Species).	1. *Hyalonema* (*Stylocalyx*) *apertum*, 2. *Hyalonema* (*Stylocalyx*) *thomsoni*, 3. *Hyalonema* (*Stylocalyx*) *depressum*, 4. *Hyalonema lusitanicum*, 5. *Hyalonema robustum*, 6. *Hyalonema* sp., 7. *Poliopogon amadou*,	232 73 246 IV. 241 241 3	1. *Hyalonema gracile*, 2. *Hyalonema divergens*, 3. *Hyalonema toxeres*, 4. *Hyalonema* (*Stylocalyx*) *depressum*, 5. *Hyalonema* (*Stylocalyx*) *globus*, 6. *Hyalonema* (*Stylocalyx*) *elegans*, 7. *Hyalonema* sp., 8. *Pheronema carpenteri*, 9. *Pheronema globosum*, 10. *Pheronema giganteum*, 11. *Semperella schultzei*,	211 271 24 271 194A 271 284, 271, 205 124 192 192 192	1. *Hyalonema poculum*, 2. *Hyalonema* (*Stylocalyx*) *conus*, 3. *Hyalonema* (*Stylocalyx*) *clavigerum*, 4. *Hyalonema* (*Stylocalyx*) *elegans*, 5. *Hyalonema tenue*, 6. *Hyalonema* sp., 7. *Poliopogon gigas*,	300 158 147, 289 323 303 170A
Species of Lyssacina,	14		26		29	
DICTYONINA—						
V. Farreidæ. (4 Species).	1. *Farrea* sp.,	56	1. *Farrea occa*, 2. *Farrea clavigera*, 3. *Farrea* sp., 4. Farreid,	24, 207 194A 23 272	1. *Farrea occa*, 2. *Farrea* sp.,	170A 135E, 147

TABLE VI.—*continued.*

	NORTH TEMPERATE ZONE.	TROPICAL ZONE.	SOUTH TEMPERATE ZONE.
VI. EURETIDÆ. (6 Species).	Station. 1. *Lefroyella decora*, . 33	Station. 1. *Eurete semperi*, . 192 2. *Eurete schmidtii*, . 192 3. *Eurete farreopsis*, . 192 4. *Eurete carteri*, . . 192 5. *Eurete marshalli*, . 192	
VII. MELITTIONIDÆ. (2 Species).	1. *Aphrocallistes bocagei*, 56	1. *Aphrocallistes bocagei*, { 24, 343, 344 2. *Aphrocallistes ramosus*, 210	
VIII. COSCINOPORIDÆ. (3 Species).	1. *Chonelasma* sp., . 56	1. *Chonelasma* sp., . 23	1. *Chonelasma lamella*, . 148A 2. *Chonelasma uncinatum*, 170A
IX. TRETODICTYIDÆ. (5 Species).		1. *Hexactinella lata*, . 192 2. *Cyrtaulon solutus*, . 192 3. *Fieldingia lagettoides*, 192 4. *Sclerothamnus clausii*, 194A	1. *Hexactinella* sp., . 148A
X. MÆANDROSPONGIDÆ. (3 Species).	1. *Dactylocalyx patella*, . 56	1. *Myliusia callocyathus*, { 24, 192, 194A 2. *Aulocystis zittelii*, . 192, 194A	
	1. Dictyonine, . . 236	1. Dictyonine, . { 192, 281, 343	1. Dictyonine, . . 286
Species of Dictyonina,	6	19	6
			1. Hexactinellid, . . 169
Species of Hexactinellida,	20	45	36

TABLE VII—DISTRIBUTION OF THE HEXACTINELLIDA OF THE CHALLENGER COLLECTION IN THE NORTHERN AND SOUTHERN HALVES OF THE TROPICAL ZONE.

NORTH TROPICAL ZONE.	Station.	SOUTH TROPICAL ZONE.	Station.
1. *Euplectella aspergillum*,	209	1. *Euplectella suberea*,	124
2. *Holascus ridleyi*,	211	2. *Euplectella crassistellata*,	274
3. *Malacosaccus unguiculatus*,	348	3. *Tægeria pulchra*,	174C
4. *Sympagella nux*,	94	4. *Dictyocalyx gracilis*,	281
5. *Polylophus philippinensis*,	209	5. *Lanuginella pupa*,	192
6. *Crateromorpha meyeri*,	209	6. *Polylophus philippinensis*,	192
7. *Aulochone lilium*,	214	7. *Crateromorpha thierfelderi*,	192
8. *Hyalonema gracile*,	211	8. *Crateromorpha murrayi*,	192
9. *Hyalonema toxeres*,	24	9. *Crateromorpha tumida*,	194A
10. *Hyalonema* sp.,	205	10. *Hyalonema divergens*,	271
11. *Semperella schultzei*,	209	11. *Hyalonema* (*Stylocalyx*) *depressum*,	271
12 *Farrea occa*,	24, 207	12. *Hyalonema* (*Stylocalyx*) *globus*,	194A
13. *Farrea* sp.,	23	13. *Hyalonema* (*Stylocalyx*) *elegans*,	271
14. *Eurete schmidtii*,	201	14. *Hyalonema* sp.,	184, 271
15. *Aphrocallistes bocagei*,	23, 24	15. *Pheronema carpenteri*,	124
16. *Aphrocallistes ramosus*,	210	16. *Pheronema globosum*,	192
17. *Chonelasma* sp.,	23	17. *Pheronema giganteum*,	192
18. *Myliusia callocyathus*,	24	18. *Semperella schultzei*,	192
		19. *Farrea clavigera*,	194A
		20. Farreid,	272
		21. *Eurete semperi*,	192
		22. *Eurete marshalli*,	192
		23. *Eurete carteri*,	192
		24. *Eurete farreopsis*,	192
		25. *Aphrocallistes bocagei*,	343, 344
		26, *Hexactinella lata*,	192
		27. *Cyrtaulon solutus*,	192
		28. *Fieldingia lagettoides*,	192
		29. *Sclerothamnus clausii*,	194A
		30. *Myliusia callocyathus*,	192, 194A
		31. *Aulocystis zittelii*,	192, 194A
		32. Dictyonine,	281, 343

It may be seen from the above that in the north temperate zone, out of 76 localities which were explored with dredge or trawl, only 11 yielded Hexactinellida. In the tropics, out of 99 dredgings or trawlings 22 were successful in the discovery of Hexactinellida. In the south temperate zone, out of a total of 101 dredgings or trawlings, 25 localities yielded Hexactinellids. Expressed in percentages the results are as follows:—

In the	north temperate zone	14·4	per cent. of the	explored localities	yielded	Hexactinellida.
,,	tropical ,,	22·2	,,	,,	,,	,,
,,	south temperate ,,	24·7	,,	,,	,,	,,

It is thus evident that the north temperate zone is by far the poorest in localities yielding Hexactinellids, and further that not the tropical, but the south temperate zone furnished both absolutely and relatively the greatest number of Hexactinellida.

The statistics are somewhat different when we consider not the number of localities, but the number of Hexactinellid species. In this connection we see that

76	dredged and trawled	localities in the	north temperate zone	yielded	20	species	= 26·3 per cent.
99	,,	,,	tropical	,,	45	,,	= 45·4 ,,
101	,,	,,	south temperate	,,	36	,,	= 35·6 ,,

The tropics are thus richer in species than even the south temperate zone.

In regard to the proportion of Hexactinellid localities in the entire northern and southern hemispheres, considered in reference to the total number of dredgings and trawlings, the statistics show that in the northern hemisphere out of 126 dredged and trawled localities 22 yielded Hexactinellids, and in the southern hemisphere out of 150 dredged and trawled localities 36 yielded Hexactinellids. The percentage proportion for the northern hemisphere is thus 17·4 per cent., and 24·0 for the southern hemisphere, so that the latter contained many more Hexactinellid localities than the former.

The total number of species found in the north hemisphere was thirty-four, while sixty-six were obtained in the south. If these numbers be collated with the number of dredged and trawled localities in each hemisphere, we have out of 126 searches in the north 27 per cent., as against 44 per cent. out of the 150 in the south. Thus the south hemisphere is seen to be about twice as rich in Hexactinellid species as the north.

Of the 50 dredged and trawled localities in the north tropical zone, 11 yielded Hexactinellida, and the number is the same for the 49 localities in the south. This, therefore, gives for the north tropical zone a percentage proportion of 22 per cent., as against 22·3 per cent. for the south tropics. The above noted important difference in localities yielding Hexactinellids in the north and south hemispheres does not therefore hold true in regard to the tropics.

The proportions are different when the *abundance of species* in the north and south tropics is taken into consideration.

The number of species found in the north tropical zone amounts to 18, as against 32

in the south. And since in the northern region 50 localities were explored with dredge and trawl, and in the south 49 localities, the percentage proportion for the former is 36 per cent., as compared with 65·3 per cent. for the latter. The south tropical region thus considerably exceeds the north as regards the abundance of species.

And if in the same way we compare the two temperate zones in relation to the abundance of Hexactinellid localities and species, the northern region shows, when compared with the southern in regard to localities, 14·4 per cent. as against 24·7 per cent., and 26·3 per cent. as against 35·6 per cent. in regard to the number of species.

There is thus a much greater abundance of Hexactinellids in the south temperate than in the north temperate zone, which is doubtless in part referable to the much greater extent of ocean in the former.

In regard further to the distribution of the subdivisions in the different zones, a review of Table VI. yields the following results :—

a. Lyssacina	In the north temperate zone,	14 species.
	In the tropics,	26 ,,
	In the south temperate zone,	29 ,,
b. Dictyonina	In the north temperate zone,	6 ,,
	In the tropics,	19 ,,
	In the south temperate zone,	6 ,,

In relation to the total number of dredgings and trawlings the percentage proportion stands as follows :—

a. Lyssacina	In the north temperate zone,	18·4 per cent.
	In the tropics,	26·3 ,,
	In the south temperate zone,	28·7 ,,
b. Dictyonina	In the north temperate zone,	7·9 ,,
	In the tropics,	19·1 ,,
	In the south temperate zone,	5·9 ,,

It is thus evident that throughout the Lyssacina preponderate, especially in the south temperate zone, where they are almost five times as numerous as the Dictyonina, while they are more than twice as abundant in the north temperate zone, and preponderate by at least 7 per cent. in the tropics.

In regard to the abundance of Lyssacina in the different zones, it is evident that the north temperate zone is considerably poorer than the tropical, and that the latter is excelled by the south temperate zone.

The relation is quite different with the Dictyonina, of which the south temperate zone contains the fewest, while the northern region a few more, and the tropics a relative abundance.

If the Lyssacina of the northern hemisphere be contrasted with those of the south,

it is seen that 25 species are found north of the equator, as against 47 to the south, while of Dictyonina 13 belong to the north, and 20 to the south hemisphere.

And since in the north hemisphere there were 126 dredgings or trawlings, as against 150 in the south, the percentage proportions for 100 dredgings or trawlings are as follows:—The Lyssacina occurred in the north hemisphere in the proportion of 19·8 per cent., as compared with 31·3 per cent. in the south; the Dictyonina are represented in the north hemisphere by 10·3 per cent., as against 13·3 in the south.

The absolute number of Lyssacina found in the north tropics was 11, as compared with 18 in the south. And if the number of dredgings or trawlings in the north and south tropics are taken into consideration, the percentage proportions stand as follows—22 per cent. in the north tropical zone, and 36·7 in the south.

Of Dictyonina 7 species were found in the north tropical zone, as against 14 species in the south. And this expressed in percentages of dredgings and trawlings means 14 per cent. for the north tropics and 28·6 for the south.

If we now pass to the consideration of the several families, it will be seen that most of them are represented in all the three zones, though generally in very varying abundance. It is noteworthy that the Euretidæ and Mæandrospongidæ are wholly absent from the south temperate zone, while the northern region exhibits a similar absence of Tretodictyidæ, and only one representative of all the other families of Dictyonina. The tropics on the other hand include representatives of almost all the families, and one at least from among the Asconematidæ and Coscinoporidæ.

While the Euplectellidæ are represented by several forms in all the three zones, the north temperate zone, which contains the genus *Euplectella* itself, yielded no Holascidæ, which occur both in the tropics and in the south temperate zone. It is a striking fact that the Asconematidæ, which occur somewhat abundantly in the south temperate zone and likewise in the north, are represented in the tropics only by a single species. The Rossellidæ occur in considerable abundance in the tropics, and in especial abundance in the south temperate zone, but are represented only by one species in the northern region.

The Hyalonematidæ exhibit a tolerably uniform distribution through all the three zones, with a slight preponderance in the tropics.

The tropics are especially rich in Farreidæ and Euretidæ, to which have to be added two species of Melittionidæ, several Tretodictyidæ, and two species of Mæandrospongidæ, a distribution in striking contrast to that of the two temperate zones, in which these families either do not occur, or are represented only by a single species.

A more detailed survey of the genera and species shows that the species of *Euplectella* occur only in the north temperate zone and in the tropics, being apparently absent in the southern region. *Euplectella aspergillum* and *Euplectella crassistellata* appear to be tropical, while *Euplectella nodosa* was confined to the north temperate zone, and *Euplectella suberea* occurred in both these regions.

The genus *Holascus* is especially represented in the south temperate zone, where three species occurred, while the tropics only yielded one species, and the north temperate zone none at all. Of the two known species of *Malacosaccus* one was found in the tropics, the other in the south temperate zone. In the same way of the two Tægerinæ, the one, *Tægeria pulchra*, occurred in the south tropics, and the other, *Walteria flemmingii*, in the south temperate zone.

In regard to Asconematidæ, *Aulascus johnstoni* was captured in the south temperate zone, *Sympagella nux* in the north tropics, and *Polyrhabdus oviformis* and *Balanites pipetta* in the south temperate zone. Of Caulophacinæ, *Caulophacus latus* was found in the south temperate zone, the other species, *Caulophacus elegans*, far removed in the northern region, and finally *Trachycaulus gurlitti* in the south temperate zone.

Of the genus *Rossella*, the only species obtained on the Challenger Expedition, *Rossella antarctica*, was entirely confined to the south temperate zone, where it was found at four different localities. In regard to the two species of *Acanthascus* and *Bathydorus*, two at least belong to the fauna of the south temperate zone, while *Bathydorus fimbriatus* occurred at two localities in the northern region. *Rhabdocalyptus* was represented by one tropical species and by a second in the south temperate zone. It seems a noteworthy fact that all known species of *Crateromorpha* were found in the tropics, while *Aulochone* was represented by one species in the tropics and by another in the south temperate zone. *Aulocalyx irregularis* appears to be widely distributed, since it was found both in the north and south temperate zones. The peculiar forms *Caulocalyx tener* and *Euryplegma auriculare* belong to the south temperate zone.

Of the species of *Hyalonema*, which were somewhat uniformly distributed in all the three zones, several were found in two zones, viz., *Hyalonema* (*Stylocalyx*) *depressum* both in the tropics and in the north temperate zone, and *Hyalonema* (*Stylocalyx*) *elegans* both in the tropics and in the south temperate zone. The species of *Pheronema* found by the expedition belong to the tropics, the two species of *Poliopogon* to the temperate zones (*Poliopogon amadou* in the north, *Poliopogon gigas* in the south), while *Semperella schultzei* was tropical.

Farrea occa occurred predominantly in the tropics, and *Farrea clavigera* exclusively so, while undefined species of *Farrea* were found in all three zones. All the five species of *Eurete* obtained on the expedition were tropical, while the beautiful *Lefroyella decora* occurred in the north temperate zone.

Aphrocallistes bocagei occurred both in the north temperate and in the tropical zone, but *Aphrocallistes ramosus* was found in the latter alone.

Chonelasma lamella and *Chonelasma uncinatum* occurred in the south temperate zone, and undefined specimens of the same genus in each of the two other zones.

The tropics yielded *Hexactinella lata*, *Cyrtaulon*, *Fieldingia*, and *Sclerothalmnus*, while in the south temperate zone only an undefined specimen of *Hexactinella* was found.

The only representative of the genus *Dactylocalyx* procured by the Challenger Expedition was found in the north temperate zone. On the other hand *Myliusia callocyathus* and *Aulocystis zittelii* were found in several localities in the tropics.

I have discussed in some detail the topographical distribution of the Challenger Hexactinellida, because I believe that the uniformity of the exploring and collecting methods, as well as the wide extent of the exploration, make the results of great value.

In estimating the number of species obtained by the Challenger in different localities, it is instructive to compare the statistics with those which are afforded us by the prolonged and enthusiastic industry of Dr. Döderlein, who made during his lengthened residence in Japan a collection of Hexactinellids, partly by purchase in Enoshima, and partly by his own dredging in Misaki Bay near Tokio, which was also explored by the Challenger. The results of his explorations have been described in detail in this Report along with the Challenger material. His collection included in all 16 species :—

1. *Euplectella oweni*, Marshall, dry.
2. *Acanthascus cactus*, F. E. S., dry.
3. *Rhabdocalyptus mollior*, F. E. S., dry.
4. *Crateromorpha meyeri*, Gray, dry.
5. *Hyalonema sieboldii*, Gray, dry.
6. *Farrea occa*, Carter, well preserved in spirit.
7. *Farrea vosmaeri*, F. E. S., dry.
8. *Farrea sollasii*, F. E. S., dry.
9. *Periphragella elisæ*, Marshall, dry and well preserved in spirit.
10. *Aphrocallistes bocagei*, Wright, in spirit.
11. *Aphrocallistes ramosus*, F. E. S., well preserved in spirit.
12. *Aphrocallistes vastus*, F. E. S., dry.
13. *Chonelasma dœderleinii*, F. E. S., well preserved in spirit.
14. *Chonelasma calyx*, F. E. S., dry.
15. *Hexactinella tubulosa*, F. E. S., dry.
16. *Hexactinella cyathus*, F. E. S., dry.

On the Challenger Expedition three soundings were made in the Bay of Misaki, at Stations 232, 236 and 236A. Station 232 yielded, from a depth of 345 fathoms, several specimens of *Hyalonema* (*Stylocalyx*) *apertum*, and Station 236, from a depth of 775 fathoms, a fragment of an undefined species of Dictyonina. In the cursory exploration of the Challenger only two Hexactinellida were thus obtained at the same locality where the prolonged search of Dr. Döderlein was rewarded by finding sixteen species. It is further of interest that among these sixteen species, the species found by the Challenger—*Hyalonema* (*Stylocalyx*) *apertum*—is not included, though it

occurs in a smaller collection of Hexactinellida dredged by Dr. Hilgendorf at the same locality, and also graciously placed at my disposal. Of course one cannot conclude from this single instance that at all the localities explored on the Challenger Expedition, eight times as many species would have rewarded a more prolonged exploration, but the facts above communicated are calculated at least to convey an impression of the relatively small proportion of the really existing Hexactinellid species that rewarded the search of an expedition so splendidly equipped and successfully conducted as that of the Challenger. And if one further considers that in spite of the large number (276) of dredgings or trawlings undertaken, immense marine regions, especially the North Arctic and the greater part of the Indian Ocean, were hardly touched upon, and that in many of the regions traversed only sample searches were made, one cannot avoid the conviction that, in spite of the relatively important increase of knowledge obtained by results of the Challenger Expedition, only a small percentage of the really existing Hexactinellid species have as yet been discovered.

BATHYMETRICAL DISTRIBUTION.

HISTORY.

In regard to the bathymetrical distribution of Hexactinellida, Marshall[1] gave in 1875 the following summary of the few results then available:—

Species.	Depth in Fathoms.	Authority.
Pheronena (Holtenia) carpenteri, ...	550	Wyv. Thomson.
Hyalonema thomsoni, ...	83	Wyv. Thomson.
Aphrocallistes bocagei, ...	700	Wyv. Thomson.
Sympagella nux, ...	100–120	Pourtalès.
Holtenia pourtalesii, O. Schmidt, . . .	150–333	Pourtalès.
Farrea facunda, O. Schmidt, ...	130–456	Pourtalès.
Dactylocalyx crispus, O. Schmidt, . . .	270	Pourtalès.
Habrodictyum speciosum, ...	83	Quoy and Gaimard.
Semperella schultzei, ...	200	Ludeking.

This list was extended by O. Schmidt's[2] report upon the Hexactinellida collected by A. Agassiz in the Gulf of Mexico, especially near the Lesser Antilles. This list, retaining O. Schmidt's nomenclature, is given on the next page.

From the above it will be seen that the depth varied from 100 to 2410 fathoms, with the exception of the record of *Cystispongia*, said to have been found near Yukatan at a depth of 20 fathoms. On this very divergent number of fathoms much weight must not be laid, since there is a possibility of error or of misprint, all the more probable since at two other localities the same species was found at depths of 136 and 292 fathoms. Leaving this divergent instance out of account, we get from Alexander Agassiz's bathymetrical statistics an average of about 500 fathoms, while 100 fathoms is the minimum depth at which any form was found. Without attempting to gather up all the scattered reports as to depths at which single Hexactinellid forms were found at various localities, I shall content myself with noting that Dr. Döderlein[3] found in the Sagami Bay, Japan, various Hexactinellids (especially *Aphrocallistes*, *Farrea*, and *Hyalonema*), at depths of 80 to 200 fathoms, It is also necessary to note some reports which have recently appeared in the results of the French Expeditions of the "Talisman" and "Travailleur," by M. Filhol[4] and M. Perrier.[5] According to these *Pheronema* were dredged from

[1] Marshall, *Zeitschr. f. wiss. Zool.*, Bd. xxv. Supplement, p. 142.
[2] Spong. Meerb. Mexico, 1880.
[3] Döderlein *Archiv f. Naturgesch.*, Jahrg. xlix. Bd. i., p. 102, 1883.
[4] La vie au fond des Mers.
[5] Les explorations sous-marines.

depths of 600 to 2200 metres, and one *Pheronema* fragment from 4789 metres. *Asconema setubalense* was dredged from a depth of 410 metres, and *Aphrocallistes bocagei* from 860 to 2200 metres. At p. 278 of his work M. Filhol notes:—"Les Hexactinellids peuvent être considerées comme de véritables habitants des grands fonds." And Edouard Perrier gathers up the results on p. 244 of his work in the following words:—"Au large des côtes de France, de Portugal et d'Afrique, c'est à un peu moins de 1000 mètres que l'on commence à rencontrer les Pheronema et les Aphrocallistes. Ces éponges sont tout à fait communes de 1000 à 1500 mètres, et s'associent alors aux Hyalonema. A partir de 1500 mètres elles deviennent rares et sont remplacées jusqu'à 2500 mètres par les Euplectelles. Aux profondeurs plus grandes les éponges sont moins communes, et sont surtout représentées par les Farrea. Ainsi les Hexactinellides elles-mêmes, qui sont les vraies éponges des grands fonds, se maintiennent dans les parties supérieures de la zone abyssale."

Species.	Depth in Fathoms.
Farrea facunda, O. Schmidt,	300–1000
Farreid,	2410
Diaretula cornu,	805
Diaretula muretta,	805
Cyathella lutea,	1591
Rhabdodictyum delicatum,	1591
Syringidium zittelii,	116–878
Aphrocallistes bocagei,	164–400
Cystispongia superstes,	[20 and] 136–292
Myliusia zittelii,	100–756
Dactylocalyx pumiceus,	103
Dactglocalyx subglobosus,	116–190
Dactocalyx potatorum,	151
Dactylocalyx callocyathus,	116–292
Margaritella cœloptychioides,	158
Joanella compressa,	287
Scleroplegma lanterna,	292–320
Scleroplegma conicum,	292
Soleroplegma seriatum,	200–300
Scleroplegma herculeum,	580
Diplacodium mixtum,	101–292
Volvulina sigsbeei,	100–292
Pachaulidium,	580
Rhabdostauridium retortula,	804
Euplectella jovis,	416–423
Regadrella phœnix,	221–288
Hertwigia falcifera,	611
Rhabdopectella tintinnus,	291–994
Hyalonema sp.,	416
Pheronema annæ,	180–248
Leiobolidium,	1507
Asconema [*Hyalonema*] *kentii*,	338–1507

BATHYMETRICAL DISTRIBUTION OF THE CHALLENGER HEXACTINELLIDA.

In order to afford a ready survey of the main results of the Challenger Expedition in regard to the bathymetrical distribution of the Hexactinellida, I have compiled Table VIII., in which the horizontal divisions mark out intervals of depth of 100 fathoms each from 100 to 1000 fathoms, and of 500 fathoms each from 1000 to 3000 fathoms, while the vertical columns correspond to the four families of Lyssacina, and the two main divisions of Dictyonina, the Uncinataria and Inermia.

This table shows distinctly that Hexactinellida occur in varying abundance only from about 100 (more exactly 95) up to 3000 (more exactly 2900) fathoms.

Thus the previously determined character of the Hexactinellida as specifically, and in fact exclusively, deep-sea forms is indubitably established, and the maximum depth previously known (2410 fathoms according to Agassiz) is exceeded by several hundred fathoms, with a maximum of 2900.

In order to express clearly the bathymetrical distribution of the Hexactinellida in the different oceans, it is convenient to tabulate not only for the whole group, but also for the several divisions, the statistics of depth and abundance, both in their absolute and percentage relations. This is done in the following table :—

TABLE VIII.

Depth in Fathoms.	No. of Dredgings or Trawlings. Total.	With Hexactinellida.	Percentage.	EUPLECTELLIDÆ.	Depth in Fathoms.	Station.	ASCONEMATIDÆ.	Depth in Fathoms.	Station.	ROSSELLIDÆ.	Depth in Fathoms.	Station.
1 to 94	42	...	...									
95 to 100	5	1	20	*Euplectella aspergillum*, . .	95	209				*Polylophus philippinensis*, . *Crateromorpha meyeri*, . .	95 95	209 209
101 to 200	26	5	19·2							*Rossella antarctica*, . . *Lanuginella pupa*, . . . *Polylophus philippinensis*, . *Crateromorpha thierfelderi*, . . *murrayi*, . . *Bathydorus stellatus*, . .	127, 140, 150 129–140 129–140 129–140 129–140 140	196H, 145, 150 192 192 192 192 307
201 to 300	8	...	...									
301 to 400	13	7	53·9				*Aulascus johnstoni*, .	310	145A	*Rhabdocalyptus roeperi*, . . . *Acanthascus dubius*, . . . *Crateromorpha tumida*, . . .	400 400 360	310 310 194A
401 to 500	11	6	54·5							*Aulochone lilium*, . . .	500	214
501 to 600	10	5	50	*Euplectella suberea*, . .	600	IV.				*Acanthascus grossularia*, . . *Rossella antarctica*, . . *Aulochone cylindrica*, . .	550 600 600	148A 320 171

TABLE VIII.—*continued.*

HYALONEMATIDÆ.	Depth in Fathoms.	Station.	UNCINATARIA.	Depth in Fathoms.	Station.	INERMIA.	Depth in Fathoms.	Station.		Depth in Fathoms.	Station.
Semperella schultzei,	95	209									
Pheronema globosum, *giganteum*, *Semperella schultzei*,	129–140 129–140 129–140	192 192 192	*Eurete schmidtii*, *semperi*, *carteri*, *farreopsis*, *Hexactinella lata*, *Cyrtaulon solutus*, *Fieldingia lagettoides*,	{ 102 { 129–140 129–140 129-140 129-140 129–140 129 140 129–140	201 192 192 192 192 192 192 192	*Myliusia callocyathus*, *Aulocystis zittelii*,	129 140 129-140	192 192	Dictyonine,	129–140	192
Hyalonema (Stylocalyx) apertum, *globus*, *toxeres*,	345 360 390	232 194 24	*Farrea clavigera*, *Sclerothamnus clausii*, *Aphrocallistes ramosus*, *Farrea occa*, *Aphrocallistes bocagei*,	360 360 375 390 390	194A 194A 19 24 24	*Myliusia callocyathus*, *Aulocystis zittelii*,	{ 360 { 390 360	194A 24 194A			
			Aphrocallistes bocagei, *Farrea sp.*, *Chonelasma sp.*, *Lefroyella decora*,	{ 420 { 425 { 450 450 450 435	344 343 23 23 23 33				Dictyonine,	425	207
Hyalonema lusitanicum,	600	IV.	*Chonelasma lamella*, *Hexactinella sp.*,	550 550	148A 148A						

TABLE VIII.—*continued.*

Depth in Fathoms.	No. of Dredgings or Trawlings. Total.	No. of Dredgings or Trawlings. With Hexactinellida.	No. of Dredgings or Trawlings. Percentage.	EUPLECTELLIDÆ.	Depth in Fathoms.	Station.	ASCONEMATIDÆ.	Depth in Fathoms.	Station.	ROSSELLIDÆ.	Depth in Fathoms.	Station.
601 to 700	9	4	44·4	*Tægeria pulchra*, . . . *Walteria flemmingii*, . .	610 630	174C 176A				*Euryplegma auriculare*, . .	630	170A
701 to 800	3	...	...									
801 to 900	3	...	...									
901 to 1000	4	2	50									
1001 to 1500	31	7	22·6	*Euplectella nodosa*, . . . *Rhabdodictyum delicatum*, . . *Euplectella suberea*, . . . *Holascus fibulatus*, . . *Malacosaccus vastus*, . . .	1075 1075 1090 1375 1375	56 56 V. 146 146	*Sympagella nux*, ...	1150	94	*Aulocalyx irregularis*, . .	1075	56
1501 to 2000	35	7	20	*Euplectella suberea*, . . . *Holascus fibulatus*, . . *polejaëvii*, . .	1600 1600 1950	124 147 157	*Caulophacus latus*, . . . *Balanites pipetta*, . . . *Polyrhabdus oviformis*, . .	1600 1950 1975	147 156 157	*Bathydorus spinosus*, . . *Aulocalyx irregularis*, . .	1600 1600	147 147
2001 to 2500	38	8	21·1	*Holascus ridleyi*, . . . *Dictyocalyx gracilis*, . . *Malacosaccus unguiculatus*, . .	2225 2385 2450	211 261 348	*Caulophacus latus*, . . . *elegans*, . .	2050 2300	246 241	*Caulocalyx tener*, . . . *Bathydorus fimbriatus*, . .	2025 2300	333 241
2501 to 3000	33	6	18·2	*Hyalostylus dives*, ... *Holascus fibulatus*, . . *stellatus*, . . *Euplectella crassistellata*, . .	2550 2600 2650 2750	289 160 325 274	*Trachycaulus gurlitti*, . .	2550	292	*Bathydorus fimbriatus*, . .	2900	248
3001 to 4000	5	...	...									

TABLE VIII.—*continued.*

HYALONEMATIDÆ.	Depth in Fathoms.	Station.	UNCINATARIA.	Depth in Fathoms.	Station.	INERMIA.	Depth in Fathoms.	Station.		Depth in Fathoms.	Station.
Poliopogon *gigas*,	630	170A	*Farrea* *occa*, *Chonelasma* *lamella*, *uncinatum*,	700 630 630 630	207 170A 170A 170A				Hexactinellid,	700	169
Hyalonema (*Stylocalyx*) *thomsoni*,	1000	73	*Farrea* sp.,	1000	135E						
Hyalonema sp., *poculum*, sp.,	 1050 1375 1400	 205 300 184	*Farrea* sp., *Aphrocallistes* *bocagei*, *Chonelasma* sp.,	 1075 1075 1075	 56 56 56	*Dactylocalyx* *patella*,	1075	56			
Poliopogon *amadou*, *Pheronema* *carpenteri*, *Hyalonema* (*Stylocalyx*) *irregularis*, *Hyalonema* *conus*, *tenue*,	 1525 1600 1600 1800 1900	 3 124 147 158 323	*Farrea* sp.,	1600	147						
Hylonema sp., (*Stylocalyx*) *depressum* *gracile*, *robustum*, *divergens*, (*Stylocalyx*) *elegans*, sp., (*Stylocalyx*) *depressum*, sp.,	 2025 2050 2225 2300 2425 2425 2300 2425 2425	 333 246 211 241 271 271 241 271 271							Dictyonine, Dictyonine,	2925 2325	293 286
Hyalonema (*Stylocalyx*) *elegans*,	2550	289	Farreid,	2600	272						

This table reveals at once the remarkable fact that a large number of localities yielding Hexactinellids, and a rich abundance of species occurred in moderate depths of 95 to 200 fathoms, while the depths from 200 to 300 are quite without Hexactinellids, which become again more abundant both in localities and species at depths from 301 to 700 fathoms, disappearing again in depths between 701 and 1000, and finally occurring in moderate abundance between 1000 and 3000 fathoms.

If regard be first had only to the number of Hexactinellid localities and their percentage among the total number of dredgings and trawlings undertaken at the relative depths, the following table represents the bathymetrical statistics for successively large ranges of 500 fathoms :—

Depth in Fathoms.	Number of Dredgings or Trawlings.	Number of Localities with Hexactinellids.	Percentage.
1–500	105	19	18
501–1000	29	10	34·8
1001–1500	31	7	22·6
1501–2000	35	7	20
2001–2500	38	8	21·1
2501–3000	33	6	18·1
3001–3500	4	0	...
3501–4000	1	0	...

In the above summary one fact might possibly cause misunderstanding, namely, that the first region is noted as 1 to 500, although it is well known that in the upper 94 fathoms no Hexactinellids whatever occur. If one excludes the dredgings or trawlings not deeper than 94 fathoms, and regards the first bathymetrical region as 95 to 500 fathoms, then out of the total 63 dredgings or trawlings, 19 yielded Hexactinellids, *i.e.*, 30·2 per cent., which is a decidedly larger figure than that given in the table, 18 per cent. It is thus seen that most Hexactinellid localities were between the depths of 95 and 1000 fathoms, while beyond this the frequency gradually decreases, finally disappearing below 3000 fathoms.

If the number of species be considered in relation to the number of dredgings or trawlings at the various depths, it is convenient to follow the plan of the large Table VIII. (p. 456) and separate the region from 1 to 94 fathoms from that from 95 to 100, and then to continue up to 1000 fathoms with ranges of 100, and with ranges of 500 up to 3000 fathoms.

Depth in Fathoms.	Number of Dredgings or Trawlings.	Number of Localities with Hexactinellids.	Number of Species.	Percentage of Species in Dredgings or Trawlings.
1–94	42	...	...	...
95–100	5	1	4	80
101–200	26	5	20	77
201–300	8	...	...	...
301–400	13	7	14	108
401–500	11	6	6	54·5
501–608	10	5	7	70
601–700	9	4	8	88·9
701–800	3	...	...	...
801–900	3	...	...	...
901–1000	4	2	2	50
1001–1500	31	7	14	45·2
1501–2000	35	7	14	40
2001–2500	38	8	15	39·4
2501–3000	33	6	4	12·4
3001–3500	4	...	...	...
3501–4000	1	...	...	...

From this summary it will be seen that at depths from 95 to 200 fathoms the probability of a dredging including a Hexactinellid is somewhat large (77 to 80 per cent.), and similarly in depths from 301 to 700 fathoms. Whether the negative results of the Challenger dredgings or trawlings for the depth 201 to 300 and 701 to 900 are really so striking as they at first sight appear, I shall leave as a moot point; the very small absolute number of dredgings or trawlings in these depths must obviously be taken into account.

Within the zones from 901 to 2500 fathoms the abundance of Hexactinellida appears to remain approximately constant at from 40 to 50 per cent. Between 2501 and 3000 a marked decrease in the number of species (to 12·4 per cent.) takes place, while at depths beyond 3000 fathoms no Hexactinellida at all were dredged.

If a tabular survey, like that given above for the Hexactinellida as a whole, be taken of the several subdivisions, the following statistic shows the relative distribution in the first place of Lyssacina and Dictyonina.

From the following table also it will be seen that at the slight depth of 95 fathoms only Lyssacina were dredged, and that Dictyonina were unrepresented, but that at depths from 101 to 1000 fathoms Dictyonina occur in equal or slightly greater abundance.

On the other hand the Dictyonina are far excelled by the Lyssacina in all depths beyond 1000 fathoms.

Depth in Fathoms.	Number of Dredgings or Trawlings.	Number of Localities with Hexactinellids.	Lyssacina.		Dictyonina.	
			Number of Species.	Percentage in Dredgings or Trawlings.	Number of Species.	Percentage in Dredgings or Trawlings.
1–94	42	...	...	...	...	...
95–100	5	1	4	80	...	...
101–200	26	5	9	34·6	10	38·5
201–300	8	...	...	...	...	...
301–400	13	7	7	53·9	7	53·8
401–500	11	6	1	9·1	5	45·4
501–600	10	5	5	50	2	20
601–700	9	4	4	44·4	3	33·3
701–800	3	...	...	...	...	...
801–900	3	...	...	...	...	...
901–1000	4	2	1	25	1	25
1001–1500	31	7	10	32·3	4	12·9
1501–2000	35	7	13	37·1	1	2·9
2001–2500	38	8	13	34·1	2	5·3
2501–3000	33	6	7	21·2	1	3
3001–3500	4	...	...	...	...	...
3501–4000	1	...	...	...	...	...

If the number of species of both divisions be computed for bathymetrical regions of 500 fathoms, and without reference to the first 94 fathoms, then the statistics read as follows :—

Depth in Fathoms.	Number of Dredgings or Trawlings.	Lyssacina.		Dictyonina.	
		Number of Species.	Percentage in the Dredgings or Trawlings.	Number of Species.	Percentage in the Dredgings or Trawlings.
95–500	105	21	20	22	21
501–1000	29	10	35	6	20·7
1001–1500	31	10	32·2	4	12·9
1501–2000	35	13	37·1	1	2·9
2001–2500	38	13	34·1	2	5·3
2501–3000	33	7	21·2	1	3
3001–3500	4	...	...	...	...
3501–4000	1	...	...	...	...

From the above this fact is distinctly evident that the Dictyonina show a much more rapid decrease of species downwards than do the Lyssacina. The percentage figures of the latter over the whole, from 95 to 3000 fathoms, vary from 20 to 37 per cent. while the percentages of the Dictyonina over the same range decrease somewhat

gradually from 21 to 3 per cent. It is therefore evident that in general the Dictyonina live at much less depths than do the Lyssacina, which are distributed with much greater uniformity over the entire bathymetrical range of the Hexactinellida.

If the consideration of these relations be extended to the several families (subdivisions in the case of the Dictyonina), very remarkable differences obtain in regard to the four families of Lyssacina. In spite of the absolute smallness of the numbers, the differences seem striking enough to merit notice here.

In regard to the Euplectellidæ, including *Euplectella aspergillum*, which lives at a depth of 95 fathoms, the following table shows the distribution in regions of 500 fathoms:—

Depth in Fathoms.	Number of Euplectellids.	Percentage in the Dredgings or Trawlings.
95–100	1	20
101–500	...	...
501–1000	3	13·5
1001–1500	5	16·1
1501–2000	3	8·6
2001–2500	3	7·9
2501–3000	4	12·1

Euplectellids are thus widely represented from a depth of 95 fathoms (*Euplectella aspergillum*) down to 3000 fathoms, and so far as an estimate with intervals of 500 fathoms is a guide they appear to be distributed with tolerable uniformity at all depths. That no Euplectellids were found on the Challenger Expedition between 100 and 500 fathoms is probably accidental. It is an interesting fact that the only Euplectellid occurring at a depth of less than 100 fathoms, viz., *Euplectella aspergillum*, belongs to those forms which, like the Dictyonina, exhibit a connected latticed framework.

Like the Euplectellidæ, the Asconematidæ are represented down to the lowest zone. The largest number of species occurs at depths between 1501 and 2000 fathoms, and from that region the number decreases both upwards and downwards, as is shown in the following scale:—

Depth in Fathoms.	Number of Asconematidæ.	Percentage in the Dredgings or Trawlings.
101–500	1	1·7
501–1000	...	...
1001–1500	1	3·2
1501–2000	3	8·6
2001–2500	2	5·3
2501–3000	1	3·3

The Rossellidæ exhibit an entirely different distribution. The maximum number of species occurs in the zone from 101 to 500 fathoms, whence it decreases very markedly downwards, while two forms were found at a depth of 95 fathoms.

Depth in Fathoms.	Number of Rossellidæ.	Percentage in the Dredgings or Trawlings.
95–100	2	40
101–500	10	17·3
501–1000	4	14
1001–1500	1	3·2
1501–2000	2	5·7
2001–2500	2	5·3
2500–3000	1	3

In contrast to the above, the Hyalonematidæ again exhibit a more uniform distribution over the entire bathymetrical range. At a depth of 95 fathoms, a single member of this group (*Semperella schultzei*) was found, while in each of the successive zones of 500 fathoms three to six species occur, until the number sinks to one in the greatest depths, as the following scale indicates:—

Depth in Fathoms.	Number of Hyalonematidæ.	Percentage in the Dredgings or Trawlings.
95–100	1	20
101–500	6	13·4
501–1000	3	10·4
1001–1500	3	9·7
1501–2000	5	14
2001–2500	6	15·8
2501–3000	1	3·3

In regard to the Uncinataria alone, what has been noted in regard to all the Dictyonina is even more conspicuous, the maximum number of species occurs in the bathymetrical zone from 101 to 500 fathoms, whence it decreases rapidly downwards to the smallest figures at the great depths. This is expressed in the following scale:—

Depth in Fathoms.	Number of Uncinataria.	Percentage in the Dredgings or Trawlings.
101–500	15	26
501–1000	5	17·3
1001–1500	3	9·7
1501–2000	1	2·8
2001–2500	...	...
2501–3000	1	3·3

The Inermia, which only occur in the lesser depths and even there only sparsely, furnish the following scale:—

Depth in Fathoms.	Number of Inermia.	Percentage in the Dredgings or Trawlings.
101–500	2	3·4
501–1000	...	...
1001–1500	1	3·2
1501–2000	...	...
2001–2500	...	...
2501–3000	...	...

Though the facts expressed above may seem to furnish somewhat scanty material for collating the bathymetrical range with the characteristics of the several genera and species, I shall at least attempt to utilise the results of the Expedition in this direction.

In the genus *Euplectella* the familiar *Euplectella aspergillum* was simply found as before near the Philippine Island, Zebu, at a depth of 95 fathoms, and therefore in comparatively shallow water; *Euplectella suberea* occurred off the Portuguese coast at depths of 600 to 1090 fathoms, and also to the north-east of Bahia at a depth 1600 fathoms; *Euplectella nodosa* occurred at a depth of 1075 fathoms near the Bermudas, and *Euplectella crassistellata*, on the other hand, at the considerable depth of 2750 fathoms in Mid Pacific.

The four species of the new genus *Holascus* frequent the greater depths. Several occurred in the South Indian Ocean between Prince Edward Island and the Crozets, others south-west of Australia, others near the Philippines, and others again east of Monte Video, at depths varying from 1375 to 2650 fathoms. With an approximately similar range from 1375 to 2450 fathoms, two species of *Malacosaccus* were procured in the Indian Ocean to the west of the Crozets Islands, and in the Atlantic, west of Guinea. The two beautiful Tægerinæ, *Tægeria pulchra* and *Walteria flemmingii*, were found in the South Pacific, near the Kermadec and the Kandavu Islands respectively, at the moderate depths of 620 and 630 fathoms.

In regard to the Asconematidæ, the genus *Aulascus*, with its single species *Aulascus johnstoni* (like the typical genus of the Asconematinæ, *Asconema* itself, which was not obtained on the Challenger Expedition) occurred at the comparatively slight depth of 310 fathoms, near Prince Edward Island. The branched *Sympagella nux* occurred near the Cape Verde Islands at a depth of 1150 fathoms, while the two other Sympagellinæ, *Polyrhabdus* and *Balanites*, were found in the southern portion of the Indian Ocean at depths of 1950 and 1975 fathoms. The stalked Caulophacinæ were dredged from

still greater depths; the two species of the genus *Caulophacus* itself occurring near the Crozets Islands and in the northern portion of the Pacific at depths of 1600 to 2300 fathoms, while *Trachycaulus gurlittii* was dredged in the South Pacific from a depth of 2550 fathoms.

The Rossellidæ were represented at the well-known locality of *Euplectella aspergillum*, off the Philippine Island, Zebu, at a depth of 95 fathoms, by *Polylophus philippinensis* and *Crateromorpha meyeri*. The former also occurred off the Sunda and Little Ki Islands at depths of 129 to 140 fathoms, along with two other species of *Crateromorpha* and the small *Lanuginella pupa; Rossella antarctica* was found at similar depths in the South Indian Ocean near Prince Edward and the Kerguelen Islands; and one species of the genus *Bathydorus* (*Bathydorus stellatus*), which is otherwise characteristic of the greater depths, was found in the Magellan Strait at a depth of only 140 fathoms. Representatives of the genera *Acanthascus* and *Rhabdocalyptus* occurred along with a *Crateromorpha, Rossella antarctica*, previously found in somewhat higher bathymetrical regions in the Magellan Strait, two species of *Aulochone*, and the peculiar *Euryplegma auriculare*, near the Kermadec Islands, at depths of 300 to 600 fathoms; *Aulocalyx irregularis* was found at the greater depth of 1075 fathoms near the Bermudas, and at 1600 fathoms near the Crozets Islands.

The maximum depth as yet known for any Hexactinellid was that of the genus *Bathydorus*, 2900 fathoms. While *Bathydorus spinosus* occurred to the east of Prince Edward Island at a depth of 1600 fathoms, *Bathydorus fimbriatus* was found about 20° to the east of Japan at a depth of 2300, in the middle of the North Pacific down as far as 2900 fathoms. In the middle of the South Atlantic, at a depth of 2025 fathoms, the peculiar species *Caulocalyx tener* occurred.

The Hyalonematid found in shallowest water was *Semperella schultzei*, which was found off the Philippine Island, Zebu, in 95 fathoms, at the Moluccas, off Little Ki Island, in 129 to 140 fathoms. At the last mentioned locality two species of *Pheronema* were also found, while the Atlantic species *Pheronema carpenteri* occurred to the south of Pernambuco at a depth of 1600 fathoms. Of the two large species of *Poliopogon*, the one occurred at a depth of 630 fathoms near the Kermadec Islands, the other to the south-west of the Canaries at a depth of 1525 fathoms.

There is a wide interval in the distribution of the different species of *Hyalonema*. While several are found at depths of 345 to 390 fathoms, most of them occur below 1000, and thence down as far as 2550 fathoms, which is the depth attained by *Hyalonema* (*Stylocalyx*) *elegans*.

The small but peculiar genus *Farrea* is represented at very various depths. Some forms occur between 300 and 400, others not above 2600 fathoms. It is different with the closely allied and externally similar Euretidæ. The four different species of the genus *Eurete* itself were all procured at the Moluccas, off Little Ki Island, from depths

of 129 to 140 fathoms, while the beautiful *Lefroyella decora* was dredged at the Bermudas from a depth of 435 fathoms.

Aphrocallistes also occurs at very diverse depths. Some forms were found near the Philippines at 375 fathoms, and off St. Thomas at 390 fathoms, while others occurred off Ascension and St. Thomas at depths of 420 to 450, and others finally at the Bermudas at a depth of 1075 fathoms. Among the Coscinoporidæ, the genus *Chonelasma* was represented at depths of 450, 630, and 1075 fathoms in the North Atlantic, the South Indian Ocean, and the South Pacific. Among the Tretodictyidæ the genus *Hexactinella* occurred near Little Ki Island at a depth of 129 to 140, off the Crozet Islands at a depth of 550 fathoms. *Cyrtaulon* and *Fieldingia* also occurred only near Little Ki Island at depths of 129 to 140 fathoms, while *Sclerothamnus* was found near the Banda Islands at slightly greater depths, down to 360 fathoms. Of the remarkable Mæandrospongidæ, *Dactylocalyx* was found below 1000 fathoms (1075) near the Bermudas. *Myliusia callocyathus*, and *Aulocystis zittelii*, on the other hand, occurred at the comparatively slight depth of 129 to 140 fathoms off Little Ki Island, and at depths of 360 to 390 fathoms near the Bermudas and St. Thomas.

INFLUENCE OF THE NATURE OF THE GROUND.

It is necessary to consider in the first instance what kind of ground or bottom is favourable to the occurrence of Hexactinellids. For this purpose the different kinds of sea-bottom may be noted, along with the number of dredgings or trawlings on each ground. Those searches must then be noted which yielded any Hexactinellida, so that their proportion to the total number for each kind of bottom may be estimated.

Then the proportionate abundance of species on each kind of bottom must be collated with the number of dredgings or trawlings. In Table IX. (p. 470) the data for this purpose are given and the general results may be summarised thus :—

Nature of the Bottom.	Number of Dredgings or Trawlings	Number of Dredgings or Trawlings with Hexactinellids.	Percentage with Hexactinellids.	Number of Species.	Percentage of Species.
1. Sand, ...	22	5	22·7	5	22·7
2. Gravel and stones, . .	3	2	66·6	2	66·6
3. Hard ground, ...	17	4	23·5	6	35·3
4. Coral mud, ...	16	2	12·5	7	43·8
5. Volcanic mud, ...	24	4	16·6	14	58·3
6. Green mud, ...	17	1	5·9	1	5·9
7. Red mud, ...	11	1	9·1	2	18·2
8. Mud (including blue mud),	53	12	22·6	32	60·4
9. Red clay, ...	39	6	15·4	11	28·2
10. Globigerina ooze, . .	53	10	19	13	24·5
11. Pteropod ooze, . . .	10	3	30	7	70
12. Radiolarian ooze, . .	4	2	50	2	50
13. Diatom ooze, ...	4	3	75	9	225

From this summary it is seen that the smallest number of localities yielding Hexactinellida occurred on those bottoms which are described as green mud and red mud. A somewhat small number were also dredged from Coral mud, volcanic mud, and red clay, and then from Globigerina ooze and mud (including blue mud), on all of which the percentage of Hexactinellid localities is over twenty-two. The same may be said of the sandy and rocky ground. The localities on Pteropod ooze were somewhat more abundant, viz., 30 per cent., and on Radiolarian ooze yet more so, viz., 50 per cent. The highest numbers refer to gravel and stones, 66·6 per cent., and to Diatom ooze, 75 per cent.

The statistics are somewhat different when the number of species found on the different bottoms is taken into consideration. Here again green mud and red mud yielded the smallest percentage of forms, viz., 5·9 per cent. and 18·2 per cent. respectively. Then

follow sand with 22·7, Globigerina ooze with 24·5, and clay with 28·2 per cent., while hard ground yielded 35·3 per cent., Coral mud 43·8 per cent., and mud (including blue mud) as much as 60·4 per cent. Radiolarian ooze yielded 50 per cent., gravel and stones 66·6 per cent., Pteropod ooze 70 per cent., and Diatom ooze as many as 225 per cent.

As one would naturally expect, the forms equipped with root tuft were principally found on soft muddy ground, on the various kinds of mud and ooze, and on red clay, while those adherent to solid bodies occurred partly on hard ground, gravel and stones, partly also on mud, both volcanic and Coral, on Pteropod ooze and on sand, being in such cases usually found attached to projecting stones or other solid bodies.

Most of the Euplectellidæ, which possess a developed basal tuft, occurred on mud (including blue mud), several also on Globigerina and Diatom ooze, and one species on each of the following—Coral mud, red clay, and Radiolarian ooze. Of the firmly attached Tægerinæ and less definitely classifiable forms, several occurred on Coral mud, one form on volcanic mud and another on red clay.

Of Asconematidæ three species occurred in Diatom ooze, two in Globigerina ooze, and one species on each of the following—sand, volcanic mud, and red clay.

The Rossellidæ were represented on very diverse bottoms, the majority (nine species) on sand, several (three on each) on red clay and volcanic mud; two on sand, two on hard ground, and two on Diatom ooze; one on gravel and stones, and another on Coral mud.

The Hyalonematidæ (Amphidiscophora) were altogether absent from sand, gravel and stones, Coral mud, and Radiolarian ooze; while hard ground, green mud, red mud, and Diatom ooze, each yielded one species; volcanic mud and Pteropod ooze each two; red clay, three; mud (including blue mud), six; and Globigerina ooze, the majority, namely, eight.

In regard to Dictyonina, the Uncinataria were altogether absent from green and red mud; one species occurred on each of the following—gravel and stones, red clay, Globigerina ooze, Radiolarian ooze, and Diatom ooze; two were found on sand, three on hard ground, and the same number on Coral mud, four on Pteropod ooze, five on volcanic mud, and ten on mud (including blue mud).

Of the few Inermia which were obtained by the Challenger, Coral mud and Pteropod ooze each yielded one, while volcanic mud and mud (including blue mud) each yielded two species.

TABLE IX.—RELATION OF THE HEXACTINELLIDA OF THE

	Sand.	Gravel and Stones.	Hard Ground.	Coral Mud.	Volcanic Mud.	Green Mud.
	Station.	Station.	Station.	Station.	Station.	Station.
EUPLECTELLIDÆ.				*Euplectella nodosa*, . 56 *Tægeria pulchra*, . 174C *Rhabdodictyum delicatum*, 56	*Walteria flemmingii*, 170A	
ASCONEMATIDÆ.	*Aulascus johnstoni*, 145A				*Sympagella nux*, . 94	
ROSSELLIDÆ.	*Rossella antarctica*, {145, 320} *Aulocalyx irregularis*, 145A	*Rossella antarctica*, 150	*Aulochone cylindrica*, 171 *Acanthascus grossularia*, 148A	*Aulocalyx irregularis*, 56	*Rossella antarctica*, 149H *Crateromorpha tumida*, . 194A *Euryplegma auriculare*, 170A	
AMPHIDISCOPHORA. S. HYALONEMATIDÆ.			*Poliopogon amadou*, . 3		*Poliopogon gigas*, . 170A *Stylocalyx globus*, . 194A	*Stylocalyx apertus*, . 232
UNCINATARIA.	Dictyonine, . 343 *Aphrocalliste bocagei*, . 344	*Eurete schmidtii*, 201	*Chonelasma lamella*, . 148A *Farrea* sp., 135E *Hexactinella* sp., . 148	*Farrea* sp., . 56 *Aphrocallistes bocagei*, . 56 *Chonelasma* sp., . 56	*Farrea clavigera*, 194A *occa*, . 170A *Chonelasma lamella*, . 170A *uncinatum*, 170A *Sclerothamnus clausii*, . 194A	
INERMIA.				*Dactylocalyx patella*, . 56	*Myliusia callocyathus*, 194A *Aulocystis zittelii*, . 194A	
	5 Localities. 5 Species.	2 Localities. 2 Species.	4 Localities 6 Species.	2 Localities. 7 Species.	4 Localities. 14 Species.	1 Locality. 1 Species.

CHALLENGER COLLECTION TO THE NATURE OF THE BOTTOM.

Red Mud.	Mud and Blue Mud.	Red Clay.	Globigerine Ooze.	Pteropod Ooze.	Radiolarian Ooze.	Diatom Ooze.
Station. *Euplectella suberea*, . 124	Station. Hexactinellid ?, 169 *Euplectella suberea*, IV. *aspergillum*, 209 *Holascus stellatus*, 325 *ridleyi*, . 211	Station. *Holascus fibulatus*, 160 *Hyalostylus dives*, . 289 *Dictyocalyx gracilis*, 281	Station. *Euplectella suberea*, . V. *Holascus fibulatus*, 146 *Malacosaccus unguiculatus*, . 348 *vastus*, . 146	Station.	Station. *Euplectella crassistellata*, 274	Station. *Holascus fibulatus*, 147 *polejaëvii*, 157
		Caulophacus elegans, . 241	*Caulophacus* sp., . 246 *tener*, . 333			*Balanites pipetta*, . 157 *Polyrhabdus oviformis*, 156 *Caulophacus latus*, . 147
	Lanuginella pupa, . 192 *Polylophus philippinensis*, . 209 *Acanthascus dubius*, . 310 *Bathydorus stellatus*, 307 *Rhabdocalyptus rœperi*, . 310 *Crateromorpha thierfelderi*, 192 *murrayi*, 192 *meyeri*, . 209 *Aulochone lilium*, . 214	*Bathydorus fimbriatus*, { 241, 248 *baculifer*, 286 *Trachycaulus gurlitti*, . 289				*Bathydorus spinosus*, 147 *Aulocalyx irregularis*, 147
Pheronema carpenteri, 124	*Hyalonema gracile*, . 211 *tenue*, . 323 sp., . 205 *Pheronema* 211 *giganteum*, 192 *globosum*, 192 *Semperella schultzei*, { 192, 209	*Hyalonema* sp., . 241 *robustum*, 241 *Stylocalyx elegans*, . 289	*Hyalonema* sp., . 184 sp., . 271 sp., . 333 *conus*, . 158 *divergens*, 271 *poculum* 300 *Stylocalyx depressus*, { 246, 271 *elegans*, . 271	*Stylocalyx thomsoni*, 73 *Hyalonema toxeres*, . 24		*Stylocalyx claviger*, 147
	Dictyonine, . 192 *Farrea occa*, . 207 *Eurete semperi*, 192 *marshalli*, 192 *carteri*, . 192 *farreopsis*, 192 *Aphrocallistes ramosus*, 210 *Hexactinella lata*, . 192 *Crytaulon solutus*, . 192 *Fieldingia lagettoides*, 192	Dictyonine, . { 281, 286	Dictyonine, . 293	*Farrea* sp., . 23 *occa*, . 24 *Aprocallistes bocagei*, { 23, 24 *Chonelasma* sp., . 23	Farreid, . 272	*Farrea* sp., . 147
	Myliusia callocyathus, 192 *Aulocystis zittelii*, . 192			*Myliusia callocyathus*, 24		
1 Locality. 2 Species.	12 Localities. 32 Species.	6 Localities. 11 Species.	10 Localities. 13 Species.	3 Localities 7 Species.	2 Localities. 2 Species.	3 Localities. 9 Species.

TABLE X.—Survey of the Hexactinellida in the Challenger Collection, and of other sufficiently described Forms, with their Localities, and the Number of Specimens obtained.

Species.	Challenger Collection.			Other Collections.		Depth in Fathoms.	Number of Specimens.
	Locality.	Nature of the Bottom.	Station.	Locality.	Authority.		
I. LYSSACINA.							
I. Hexasterophora.							
I. Euplectellidæ.							
1. Euplectellinæ.							
1. *Euplectella*, Owen.							
1. *Euplectella aspergillum*, Owen,	Zebu, Philippines,	...	209	... ...	...	95-100	many
				Philippines,	Owen,	...	...
				Bohol and Zebu, Philippines,	Bowerbank,	...	...
				Philippines,	Semper,	...	...
				Zebu,	Claus,	...	...
				Cape St. Vincent, off Portugal,	Higgins,	...	...
2. *Euplectella suberea*, Wyv. Thomson,	South-east of Cape St. Vincent,	bl. m.	IV.	... ...	...	600	1
	West of Gibraltar,	gl. oz.	V.	... ...	...	1090	1
	North-east of the Rio San Francisco,	r. m.	124	... ...	...	1600	1
				North of Scotland,	Wyv. Thomson,	...	...
				North Atlantic,	Filhol,	...	...
3. *Euplectella cucumer*, Owen,	... ...	...	...	Seychelles Islands,	Owen,	...	1
4. *Euplectella jovis*, O. Schmidt,	... ...	...	...	St. Lucia (423) and Grenada (416), Gulf of Mexico,	O. Schmidt,	433, 416	several
5. *Euplectella oweni*, Herklots and Marshall,	... ...	...	...	Japan,	Marshall,	...	several
6. *Euplectella crassistellata*, n. sp.,	North-west of the Caroline Islands,	rad. oz.	274	... ...	...	2750	1
7. *Euplectella* (?) *nodosa*, n. sp.,	Off Bermudas,	...	...	... ...	...	...	1
2. *Regadrella*, O. Schmidt.							
Regadrella phœnix, O. Schmidt,	... ...	...	...	Barbados (221, 288), Santa Cruz (248, stones), Gulf of Mexico,	O. Schmidt,	221, 288, 248	several
2. Holascinæ.							
1. *Holascus*, n. gen.							
1. *Holascus stellatus*, n. sp.,	East of Monte Video,	bl. m.	325	... ...	...	2650	2
2. *Holascus fibulatus*, n. sp.,	Marion Island to Crozets,	gl. oz.	146	... ...	...	1375	1
	West of the Crozet Islands,	di. oz.	147	... ...	...	1600	several
	West of Tasmania,	r. cl.	160	... ...	...	2600	1
3. *Holascus polejaëvii*, n. sp.,	Southern Ocean,	di. oz.	157	... ...	...	1950	1
4. *Holascus ridleyi*, n. sp.,	West of Mindanao,	bl. m.	211	... ...	...	2225	1
2. *Malacosaccus*, n. gen.							
1. *Malacosaccus vastus*, n. sp.,	Marion Island to the Crozets,	gl. oz.	146	... ...	...	1375	1
2. *Malacosaccus unguiculatus*, n. sp.,	South of Sierra Leone,	gl. oz.	348	... ...	...	2450	1
3. Tægerinæ.							
1. *Tægeria*, n. gen.							
Tægeria pulchra, n. sp.,	Fiji Islands,	crl. m.	174c	... ...	...	61	1

TABLE X.—*continued.*

Species.	Challenger Collection. Locality.	Nature of the Bottom.	Station.	Other Collections. Locality.	Authority.	Depth in Fathoms.	Number of Specimens.
2. *Walteria*, n. gen.							
Walteria flemmingii, n. sp.,	Off the Kermadec Islands,	volc. m.	170A	...	...	630	1
Habrodictyum, Wyv. Thomson.							
Habrodictyum speciosum, Quoy et Gaimard,	...	...	...	Moluccas,	...	...	several
Eudictyum, Marshall.							
Eudictyum elegans, Marshall,	...	...	...	Unknown,	...	...	...
Dictyocalyx, n. gen.							
Dictyocalyx gracilis, n. sp.,	South of Tahiti,	r. cl.	281	...	...	2385	1
				Bequia, Gulf of Mexico,	O. Schmidt,	1591	...
Rhabdodictyum, O. Schmidt.							
Rhabdodictyum delicatum, O. Schmidt,	South-west of the Bermudas,	c. m.	56	...	...	1075	2
				Bequia, Gulf of Mexico,	O. Schmidt,	1591	...
Rhabdopectella, O. Schmidt.							
Rhabdopectella tintinnus, O. Schmidt,	...	...	...	Grenada,	O. Schmidt,	291, 994	
Hertwigia, O. Schmidt.							
Hertwigia falcifera, O. Schmidt,	...	...	...	Dominica,	O. Schmidt,	611	...
Hyalostylus, n. gen.							
Hyalostylus dives, n. sp.,	South Pacific,	...	289	...	...	2550	1
II. Asconematidæ. 1. Asconematinæ. 1. *Asconema*, Sav. Kent.							
Asconema setubalense, Sav. Kent,	...	...	...	Off coast of Portugal, Færöe Channel, "Triton" Expedition, Station 4,	Murray,	327–430	1
2. *Aulascus*, n. gen.							
Aulascus johnstoni, n. sp.,	South-east of Prince Edward Island,	...	145A	...	...	310	2
2. Sympagellinæ. 1. *Sympagella*, O. Schmidt.							
Sympagella nux, O. Schmidt,	Porto Prayo and St. Iago, Cape Verde Islands,	...	...	...	...	100–128	1
				Florida,	O. Schmidt,	98, 123	
2. *Polyrhabdus*, n. gen.							
Polyrhabdus oviformis, n. sp.,	Southern Ocean,	di. oz.	156	...	...	1975	1
3. *Balanites*, n. gen.							
Balanites pipetta, n. sp.,	Southern Ocean,	di. oz.	157	...	...	1950	1

TABLE X.—*continued.*

Species.	Challenger Collection. Locality.	Nature of the Bottom.	Station.	Other Collections. Locality.	Authority.	Depth in Fathoms.	Number of Specimens.
3. Caulophacinæ.							
1. *Caulophacus*, n. gen.							
1. *Caulophacus latus*, n. sp.,	West of the Crozet Islands,	di. oz.	147			1600	1
2. *Caulophacus elegans*, n. sp.,	East of Yokohama,	r. cl.	241			2300	3
2. *Trachycaulus*, n. gen.							
Trachycaulus gurlittii, n. sp.,	South Atlantic,	r. cl.	289	... ...	...	2550	1
III. Rossellidæ.							
1. *Lanuginella*, O. Schmidt.							
Lanuginella pupa, O. Schmidt,	Little Ki Island,	bl. m.	192	... ...	...	129–140	several
				St. Iago, Cape Verde Islands,	O. Schmidt,	...	...
2. *Polylophus*, n. gen.							
Polylophus philippinensis, Gray,	Zebu, Philippines,	...	209	... ...	...	95–100	many
				Zebu, Philippines,	Gray,	...	...
3. *Rossella*, Carter.							
1. *Rossella antarctica*, Carter,	Off Marion Island,	volc. sd.	145	... ...		310	several
	Off Cumberland Bay, Kerguelen Island,	volc. m.	149H	... ...	...	120	several
	Heard Island,	co. gr.	150	... ...	..	150	many
	South-east of Monte Video,	gr. & sd.	320	... ...	...	600	2
				Antarctic Ocean, lat. 74°–77° S., long. 175° W.,	Carter,	206–300	...
2. *Rossella velata*, Wyv. Thomson,	... ...	...	...	Strait of Gibraltar, "Porcupine" Expedition,	Wyv. Thomson,	651	...
4. *Acanthascus*, n. sp.							
1. *Acanthascus grossularia*, n. sp.,	Possession Island, Crozets,	hd. gr.	148	... ...		210	1
2. *Acanthascus dubius*, n. sp.,	South of Puerto Bueno, Magellan Strait,	bl. m.	310	... ...	...	400	1
3. *Acanthascus cactus*, n. sp.,	... ...	...	...	Sagami Bay, Japan,	Döderlein,	...	1
5. *Bathydorus*, n. gen.							
1. *Bathydorus fimbriatus*, n. sp.,	North Pacific,	r. cl.	241	.. ...	...	2300	1
	North Pacific,	r. cl.	248		...	2900	1
2. *Bathydorus stellatus*, n. sp.,	Port Grappler, Magellan Strait,	bl. m.	307			140	1
3. *Bathydorus spinosus*, n. sp.,	West of the Crozets,	di. oz.	147	... ...	...	1600	
4. *Bathydorus baculifer*, n. sp.,	South Pacific,	r. cl.	286	... ...	...	2335	1
6. *Rhabdocalyptus*, n. gen.							
1. *Rhabdocalyptus mollis*, n. sp.,	... ...	...	...	Sagami Bay, Japan,	Döderlein,	...	2
2. *Rhabdocalyptus roeperi*, n. sp.,	South of Puerto Bello, Magellan Strait,	bl. m.	310	... ...	...	400	1
7. *Crateromorpha*, Gray.							
1. *Crateromorpha meyeri*, Gray,	Zebu, Philippines,	bl. m.	near 209	... ...	...	95	several
				Zebu, Philippines,	Gray and Carter,	...	...

Table X.—*continued.*

Species.	Challenger Collection. Locality.	Challenger Collection. Nature of the Bottom.	Challenger Collection. Station.	Other Collections. Locality.	Other Collections. Authority.	Depth in Fathoms.	Number of Specimens.
2. *Crateromorpha thierfelderi*, n. sp.,	Off Little Ki Island,	bl. m.	192	...	...	129–140	1
3. *Crateromorpha murrayi*, n. sp.,	Off Little Ki Island,	bl. m.	192	...	...	129–140	1
4. *Crateromorpha tumida*,	Off Banda,	bl. m.	194	...		360	1
8. *Aulochone*, n. gen.							
1. *Aulochone cylindrica*, n. sp.,	North of Raoul and Kermadec Islands,	hd. gd.	171	...		600	1
2. *Aulochone lilium*, n. sp.,	South-east of Mindanao, Philippines,	bl. m.	214	...		500	1
9. *Caulocalyx*, n. gen.							
Caulocalyx tener, n. sp.,	South Atlantic,	gl. oz.	333	...	...	2025	1
10. *Aulocalyx*, n. gen.							
Aulocalyx irregularis, n. sp.,	South-west of the Bermudas,	volc. sd.	56	...	...	1075	1
	South-east of Prince Edward Island,	volc. sd.	145A	...	...	310	several
	West of Crozets,	di. oz.	147	...	...	1600	1
11. *Euryplegma*, n. gen.							
Euryplegma auriculare, n. sp.,	North-east of Kermadec Islands,	...	170A	...	...	630	1
II. Amphidiscophora. Hyalonematidæ. 1. Hyalonematinæ. 1. *Hyalonema.* 1. *Hyalonema*, *s. str.*							
1. *Hyalonema sieboldi*, Gray,	...	...	...	Japan, Sagami Bay, Japan,	Gray, Döderlein and Hilgendorf,	... circa 200	... several
2. *Hyalonema gracile*, n. sp.,	West of Mindanao, Philippines,	bl. m.	211	...	...	2225	1
3. *Hyalonema divergens*, n. sp.,	Mid Pacific,	gl. oz.	271	...	...	2425	1
4. *Hyalonema kentii*, O. Schmidt,	...	...	...	Grenada (338, 576), Martinique (565), Guadeloupe (583), Bequia (1507), Gulf of Mexico,	O. Schmidt,	338–1507	...
5. *Hyalonema toxeres*, Wyv. Thomson,	North of St. Thomas, West Indies,	pt. oz.	24	...	...	390	3
6. *Hyalonema poculum*, n. sp.,	Juan Fernandez,	gl. oz.	300	...		1375	1
7. *Hyalonema conus*, n. sp.,	South Pacific,	gl. oz.	158	...	...	1800	1
2. *Stylocalyx.*							
1. *Stylocalyx thomsonii*, Marshall,	West of the Azores Islands,	pt. oz.	73	...	...	1000	1
				North of Shetland Islands,	Marshall,	550	
2. *Stylocalyx apertus*, n. sp.,	Sagami Bay, Japan,	gr. m.	232	...	...	345	several
3. *Stylocalyx depressus*, n. sp.,	North Pacific,	gl. oz.	246	...	...	2050	several
	Mid Pacific,	...	271	...	...	2425	2

TABLE X.—*continued.*

Species.	Challenger Collection.			Other Collections.		Depth in Fathoms.	Number of Specimens.
	Locality.	Nature of the Bottom.	Station.	Locality.	Authority.		
4. *Stylocalyx claviger*, n. sp.,	West of the Crozets,	di. oz.	147	... ...	...	1600	1
5. *Stylocalyx globus*, n. sp.,	Off Banda,	volc. m.	194A	... ...	...	360	1
6. *Stylocalyx elegans*, n. sp.,	South of Hawaii,	gl. oz.	271	... ...	...	2425	1
7. *Stylocalyx tener*, n. sp.,	South Pacific,	r. cl.	289	... ...	...	2550	1
Hyalonema lusitanicum (?), Barboza du Bocage,	South-east of Cape St. Vincent; west of Gibraltar,	m.	IV.	... ...	...	600	1
				Portugal,	Barboza,	...	...
Hyalonema cebuense, Higgin,	... ...	...	...	Zebu, Philippines,	Higgin,	...	1
Hyalonema tenue, n. sp.,	East of Buenos Ayres,	bl. m.	323	... ...	...	1900	1
Hyalonema robustum, n. sp.,	North Pacific,	r. cl.	241	... ...	...	2300	1
Hyalonema sp.,	South-east of Cape York, Torres Strait,	gl. oz.	184	... ...	...	1400	1
Hyalonema sp.,	West of Luzon, Philippines,	bl. m.	205	... ...	...	1075	1
Hyalonema sp.,	Mid Pacific,	gl. oz.	271	... ...	...	2425	1
Hyalonema sp.,	South Atlantic,	gl. oz.	333	... ...	...	2025	1
2. *Pheronema*, Leidy.							
1. *Pheronema annæ*, Leidy.,	... ...	...	...	Santa Cruz, West Indies,	Leidy,	...	1
				Santa Cruz,	O. Schmidt,	180–248	several
2. *Pheronema carpenteri*, Wyv. Thomson,	Off Macio, Brazil,	...	124	... ...	...	1600	several
				North-west of Scotland,	Wyv. Thomson,	...	...
				West of the English Channel,	Wyv. Thomson,	...	...
				"Lightning" Expedition, No. 12,	...	530	4
				"Porcupine," Station 42,	...	862	several
				"Triton Expedition, Station 13,	...	570	1
3. *Pheronema grayi*, Sav. Kent,	... ...	...	...	Off Setubal, Portugal,	Sav. Kent,	...	several
4. *Pheronema hemisphæricum*, Gray,	... ...	...	...	Singapore,	Gray,	...	1
5. *Pheronema globosum*, n. sp.,	Off Little Ki Island,	bl. m.	192	... ...	...	140	several
6. *Pheronema giganteum*, n. sp.,	Off Little Ki Island,	bl. m.	192	... ...	...	140	1
3. *Poliopogon*, Wyv. Thomson.							
1. *Poliopogon amadou*, Wyv. Thomson,	South-west of Canary Islands,	hd. gd.	3	... ...	...	1525	2
2. *Poliopogon gigas*, n. sp.,	Between Kermadec and Raoul Islands,	volc. m.	170A	... ...	...	630	1
2. Semperellinæ. *Semperella*, Gray.							
Semperella schultzei, Semper,	Off Zebu, Philippines,	...	209	... ...	...	100	1
	Off Little Ki Island,	...	325	... ...	...	140	1
				Philippines,	Semper and Gray,	...	...

TABLE X.—*continued.*

Species.	Challenger Collection. Locality.	Nature of the Bottom.	Station.	Other Collections. Locality.	Authority.	Depth in Fathoms.	Number of Specimens.
II. DICTYONINA, Zittel.							
I. UNCINATARIA							
I. CLAVULARIA.							
Farreidæ.							
Farrea, Bowerbank.							
1. *Farrea occa*, Carter.	North of St. Thomas, West Indies,	pt. oz.	24	... ...	...	390	1
	North-east of Kermadec Islands,	volc. m.	170	... ...	...	520	1
	Philippines,	bl. m.	207	... ...	...	700	1
				Off Misaki, Japan,	Döderlein & Carter,	...	...
				Sagami Bay, Japan,	Döderlein,	...	several
2. *Farrea sollasii*, n. sp.,	... ...	...	...	Sagami Bay, Japan,	Döderlein,	...	1
3. *Farrea vosmaeri*, n. sp.,	... ...	...	...	Sagami Bay, Japan,	Döderlein,	...	1
4. *Farrea clavigera*, n. sp.,	Off Banda,	volc. m.	194A	... ...	...	200–360	1
Farrea sp. (? *woodwardi*, Sav. Kent),	... ...	...	...	Portugal,	...	...	..
Farrea sp.,	Off Sombrero, West Indies,	pt. oz.	23	... ...	...	450	1
Farrea sp.,	South-west of Bermuda,	crl. m.	56	... ...	...	1075	1
Farrea sp.,	Off Tristan da Cunha,	hd. gd.	135E	... ...	...	1000	1
Farrea sp.,	West of the Crozets,	di. oz.	147	... ...	...	1600	1
2. SCOPULARIA.							
1. Euretidæ, F. E. S.							
1. *Eurete*, Carter.							
1. *Eurete semperi*, n. sp.,	Off Little Ki Island,	bl. m.	192	... ...	...	140	1
2. *Eurete schmidtii*, n. sp.,	Off Samboangan, Philippines,	st. gr.	201	... ...	...	102	2
3. *Eurete farreopsis*, Carter,	Off Little Ki Island,	bl. m.	192	... ...	...	140	2
4. *Eurete carteri*, n. sp.,	Off Little Ki Island,	bl. m.	192	... ...	...	140	2
5. *Eurete marshalli*, n. sp.,	Off Little Ki Island,	bl. m.	192	... ...	...	140	1
6. *Eurete bowerbankii*, n. sp.,	... ...	...	...	Sagami Bay, Japan,	Döderlein,	...	1
Eurete sp. (*simplicissima*, Semper),	... ...	...	...	Zebu, Philippines,	Semper,	..	...
2. *Periphragella*, Marshall.							
Periphragella elisæ, Marshall,	... ...	...	...	Moluccas,	Marshall,	..	5
				Sagami Bay, Japan,	Döderlein, Gottsche, Hilgendorf,	..	..
3. *Lefroyella*, Wyv. Thomson.							
Lefroyella decora, Wyv. Thomson,	Off Bermudas,	...	...	... ...	...	...	2

TABLE X.—*continued.*

Species.	Challenger Collection. Locality.	Nature of the Bottom.	Station.	Other Collections. Locality.	Authority.	Depth in Fathoms.	Number of Specimens.
II. Melittionidæ, Zittel. *Aphrocallistes*, Gray.							
1. *Aphrocallistes bocagei*, Perceval Wright,	South-west of Ascension Island,	volc. sd.	343	...	...	425	1
	Off St. Thomas, West Indies,	pt. oz.	23	...	...	450	1
	Off St Thomas, West Indies,	pt. oz.	24	...	...	390	1
	South-west of Bermudas,	crl. m.	56	...	...	1075	several
	West of Ascension Island,	volc. sd.	344	...	...	420	several
				South-east of coast of Spain, "Porcupine" Exp.,	...	...	...
				Cape Verde Islands,	Wright,	...	...
				South-east of Florida,	O. Schmidt,	...	...
				Off Spain and Portugal,	Sav. Kent,	...	...
				Off France and Portugal,	Milne-Edwards,	...	...
2. *Aphrocallistes ramosus*, n. sp.,	Philippines,	bl. m.	210	...	...	375	...
				Sagami Bay,	Döderlein,	...	...
3. *Aphrocallistes vastus*, n. sp.,				Sagami Bay,	Döderlein, Gottsche,	...	...
4. *Aphrocallistes beatrix*, Gray,	...		...	Off Malacca,	Gray,	...	1
III. Coscinoporidæ, Zittel. *Chonelasma* n. gen.							
1. *Chonelasma lamella*, n. sp.,	South of Possession Island, Crozets,	hd. gd.	148A	...	...	550	1
	North-east of Kermadec Islands,	volc. m.	170A	...	...	630	1
2. *Chonelasma hamatum*, n. sp.,	North-east of Kermadec Islands,	volc. m.	170A	...	...	630	1
3. *Chonelasma dœderleinii*, n. sp.,	...	...	...	Sagami Bay, Japan,	Döderlien,	...	1
4. *Chonelasma calyx*, n. sp.,	...	...	...	Sagami Bay, Japan,	Döderlien,	...	1
Chonelasma sp.,	Off St. Thomas, West Indies,	pt. oz.	23	...	...	450	1
	South-west of Bermudas,	crl. m.	56	...	...	1075	1
	South of Possession Island,	...	148A	...	...	550	1
	Off coast of Portugal,	...	...	...	...	...	...
IV. Tretodictyidæ. 1. *Hexactinella*, Carter.							
1. *Hexactinella tubulosa*, n. sp.,	...	...	...	Sagami Bay,	Döederlein,	...	several
2. *Hexactinella lata*, n. sp.,	Off Little Ki Island,	bl. m.	192	...	...	140	several
3. *Hexactinella ventilabrum*, Carter,	...	...	...	Japan,	Carter,	...	...
				Sagami Bay,	Döderlein,	...	1
Hexactinella sp.,	South of Possession Island, Crozets,	hd. gd.	148A	...	...	550	1
2. *Cyrtaulon*, n. gen.							
1. *Cyrtaulon sigsbeei*, O. Schmidt,	...	...	...	Barbados,	O. Schmidt,	158, 100	...
				Morrolight,	...	292	...
				St. Vincent,	...	124	3
2. *Cyrtaulon solutus*, n. sp.,	Off Little Ki Island,	bl. m.	192	...	...	140	1

TABLE X.—*continued.*

Species.	Challenger Collection. Locality.	Nature of the Bottom.	Station.	Other Collections. Locality.	Authority.	Depth in Fathoms.	Number of Specimens.
4. *Fieldingia*, Sav. Kent.							
Fieldingia lagettoides, Sav. Kent,	Off Little Ki Island,	bl. m.	192	...	...	140	1
				Off Cezimbra, Portugal,	Sav. Kent,	500	1
5. *Sclerothamnus*, Marshall.							
Sclerothamnus clausii, Marshall,	Off Banda,	volc. m.	194A	...	.	360	1
				Off Negros and Zebu, Philippines,	Murie,	80, 100	1
V. Mæandrospongidæ, Zittel. 1. *Dactylocalyx*, Stutchbury.							
1. *Dactylocalyx pumiceus*, Stutchbury,	...	..	.	Off Barbados, St. Vincent,	Stutchbury, O. Schmidt,	103	several
2. *Dactylocalyx subglobosus*, Gray,	...		..	Malacca?,	Gray,	.	...
				St Lucia,	...	116	.
				North-west of Havanna,	O. Schmidt,	190	..
3. *Dactylocalyx patella*, n. sp.,	South-west of Bermuda,	.	56	...	..	1075	1
	Off coast of Portugal,	..	..	...	...	...	1
2. *Scleroplegma*, O. Schmidt.							
Scleroplegma conicum, O. Schmidt,	...	..	...	Morrolight, West Indies,	O. Schmidt	292	
3. *Myliusia*, Gray.							
Myliusia callocyathus, Gray,	Off St. Thomas, West Indies,	pt. oz.	24	...	...	390	1
	Off Little Ki Island,	bl. m.	192	...	...	140	3
	Off Banda,	volc. m.	194A	...	...	360	1
				West Indies,	Gray,	...	..
4. *Aulocystis*, n. gen.							
1. *Aulocystis grayi*, Bowerbank,	...	...	..	Off St. Vincent, West Indies,	Bowerbank,	.	
2. *Aulocystis zittelii*, Marshall,	Off Little Ki Island,	bl. m.	192	...	...	140	1
	Off Banda,	volc. m.	194A	...	...	360	1
				Zebu, Philippines,	Meyer and Marshall,	.	

List of Species of recent Hexactinellida arranged Alphabetically.

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THE PHYLOGENY OF THE HEXACTINELLIDA.

After a detailed investigation of a group of animals, it is incumbent on every naturalist who accepts the evolution theory to attempt the appreciation of his results in their relation to the phylogeny of the group.

In attempting to draw conclusions from the results of my investigation of living forms, I am indeed conscious that such deductions as to pedigree cannot claim to have any absolute certainty, and that the less since, in spite of the splendid work of Zittel, the anatomical and embryological facts can be but slightly supplemented by the results of palæontological research. Certain skeletal portions of fossil Hexactinellida, and especially the connected framework, have indeed sometimes been found wonderfully preserved, and, after separation from adjacent material by careful maceration in acids, have even admitted of very intimate study. But the siliceous spicules occurring loosely in the parenchyma, and specially important for diagnosis, are as a rule not preserved at all. Of the soft parts there is furthermore no trace; and, finally, the fossil remains that have been found represent only some small divisions of the entire class. I must therefore restrict myself simply to collating the conclusions drawn from the living forms with the few results of palæontological research, to show at least to what extent they harmonise.

In the discussion of the phylogenetic relations of living Hexactinellids to one another and to known fossil forms, I shall have repeatedly to refer to the papers which I have in the past year laid before the Berlin Academy.[1] There can be no doubt, to any evolutionist, that the close resemblance, both in general structure and details of organisation, which is expressed in the grouping of different forms in the systematic unities of species or even genera must be based upon, and explained in terms of real relationship. But the greater the extent of the systematic categories, the greater usually are the gaps which are seen to exist in the living fauna, and the more difficult does it become to determine the actual relationships. The conventional method of representing the various forms in a continuous series is felt to be much more insufficient when dealing with the larger divisions than when expressing the relations of the usually simpler varieties of a species or of the members of a genus.

[1] *Abhandl. d. Königl. Preuss. Akad.*, 1886.

This becomes at once very evident when we consider the two great subdivisions of Lyssacina and Dictyonina, which, according to most modern investigators of sponges, and in my opinion also, may be recognised in the Hexactinellida. The question at once arises whether these two divisions, regarded in classification as of approximately equal importance, are to be expressed by the forking of a common stem, or are not rather to be considered as the continuous but successive divisions of one ramified tree. In the first case we must suppose that the two divisions with divergent forms originated almost or quite contemporaneously from a common ancestral form, and that each developing by itself in a special direction gradually exhibited the distinctive characters of the modern forms. In the second case we have to suppose that the ancestors of the higher division must at first have had the characters of the lower, and have been systematically included within it,—we must suppose, that is to say, that the one division sprang from the other.

But before I proceed to the discussion of this and similar questions, I shall briefly review the relative opinions of previous investigators.

In his researches on Hexactinellida,[1] published in 1875, Marshall says:—"The state of skeletal coalescence" (in which the axial canals of the framework beams are said to form one connected anastomosing system) "I regard as phylogenetically oldest, as that from which have developed the Hexactinellida with free siliceous elements, and especially those with predominantly hexradiate spicules, which may be regarded as simply inherited. By adaptation we account for the large series of frequently very beautiful forms, for which Bowerbank has invented such an elaborate nomenclature. The third state, that of fusion, appears to arise in different ways: (1) by the simple union of the ensheathing substance of two adjacent spicules; (2) by lamella-like structures which extend like bridges between two adjacent but not directly apposed spicules; (3) by the development of lamellar layers of flinty material round two parallel and adjacent spicules."

In the memoir entitled Ideen über die Verwandtschaftsverhältnisse der Hexactinelliden,[2] Marshall has more definitely expressed his conclusions as to the phylogeny of the Hexactinellida. Starting from a Chalynthus-like ancestral form without skeleton, he regards it as probable that in the wall of this simple sack somewhat firmer longitudinal, circular, and radial strands of "hardened protoplasmic material" were developed, intersecting at right angles, and forming a connected fibrous framework with square or cubical meshes. "The next form," Marshall continues (*loc. cit*, p. 119), "is thus a sponge with simple connected siliceous lattice work, in which the central canals are also connected, and which has not yet acquired any functionally important free spicules. From such a simple Protohexactinellid there have developed, on the one hand, forms like *Sclerothamnus*, with single free spicules, and, on the other hand, forms in which

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxv., Supplement.

[2] *Op. cit.*, Bd. xxvii. p. 111

the connection of the axial canals no longer occurs, though secondary development still results in the formation of a connected skeleton, and in which there are no special needles developed besides the regular hexacts. On this phylogenetic theory, *Eurete*" (which according to Marshall is entirely without isolated siliceous elements) "is of importance, while an ontogenetic recapitulation of the development is illustrated by the extremely simple embryo of *Hyalonema*, which I (Marshall) have described."

From the still extant genus *Sclerothamnus*, representing the ancestral form, Marshall derives the group of Synauloidæ, in which "the lumina of the spicules, as well as the spicules themselves, are continuously connected with one another, so that the whole lattice-work of the sponge is penetrated by a uniformly connected system of tubes." The other modern Hexactinellida are united by Marshall into the group Asynauloidæ, "in which the lumina of the stalks of the various spicules are never connected, but each spicule, so far as its central filaments are concerned, forms an independently developed individual. Where a lattice-work is developed, that is exclusively the result of a syncytium formed by the secretion of layers of siliceous material."

We thus see that Marshall regards the presence of a special form of dictyonal framework as the oldest type of Hexactinellid skeleton, from which the forms described as Lyssacina (with isolated hexradiate spicules) have afterwards developed. In many of the latter a secondary union of the hexradiate spicules again results in the formation of a connected siliceous framework (the dictyonal framework of our Dictyonina), and at first of this alone, as in *Eurete*, but afterwards also with the association of adjacent isolated spicules. In other derived forms the secondary fusion of the spicules has not occurred, but the form of the isolated spicules has become more or less complicated.

In 1877, in his Studies on ossil Sponges,[1] Zittel applied the results of his investigation of abundant palæontological material to the elucidation of the system and phylogeny of the Hexactinellida. His conclusions agree in several points with those of Marshall, but differ not inconsiderably in others. "Were it true," Zittel says (*loc. cit.*, p. 19), "that the compact Hexactinellid skeleton was developed from a special framework of delicate protoplasmic strands, then the older fossil forms must necessarily, on Marshall's theory, belong to the Synauloidæ. This is not, however, by any means the case. My researches on fossil forms have shown that the connected lattice-works consist without exception of fused hexradiate spicules, in which the axial canals are indeed frequently apposed and seem to form closed and connected tubes, but are in reality always separate, while they usually lie, as in the living genera *Farrea*, *Eurete*, and *Aphrocallistes* so that the axial filaments of the different hexacts are seen to be distinctly separate."

After Zittel had shown that, even in *Sclerothamnus*, the axial canals of the lattice framework do *not* form an open anastomosis, but are referable throughout to single

[1] *Abhandl. d. II. Cl. k. baier. Akad. d. Wiss.*, Bd. xiii. Abth. 1.

fused hexacts with blind processes lying side by side, he was led altogether to deny the accuracy of Marshall's group of Synauloidæ. He also threw doubt on the correctness of Marshall's representation of *Eurete*, Semper, as a Monacid. On this account Zittel divides all the Hexactinellida into two main divisions,—Lyssacina, in which "the skeletal spicules generally remain isolated, and only united by protoplasm" and Dictyonina, in which "the skeletal spicules are fused in a regular way, and form a connected lattice-work with cubical or polyhedral meshes." The soldering of the spicules into a compact connected framework, as occurs in some Lyssacina such as *Euplectella aspergillum*, cannot be identified in mode or nature of union with the regular fusion of a distinct dictyonal skeleton. The irregularity of arrangement, and the inhibition of further development of the spicules as the consequence of this external union, demonstrate the secondary importance of the former case.

For the further classification of the Lyssacina, Zittel emphasises, like Marshall, the degree of differentiation exhibited by the loose spicules, and forms three families:—(1) Monacidæ (Zittel), with only a single form with loose skeletal elements, including also the few known fossil Lyssacina (like *Astræospongia*, Röm, and *Stauractinella*, Zittel); (2) Pleionacidæ, Marshall, in which the main mass of the skeleton consists of regular hexacts, in association with broom-forks and rosettes (*Asconema*, S. Kent, and *Lanuginella*, O. Schmidt); and (3) Pollacidæ, Marshall, in which the form of the skeletal and loose spicules is very manifold, especially in the dermal skeleton and in the lining of the enteric cavities, while the base usually bears a root-tuft of long siliceous spicules (numerous living and some fossil forms). The Dictyonina, on the other hand, are divided by Zittel into a large number of families with complicated characteristics.

In an essay by Marshall and Meyer[1] on some new or slightly known Philippine Hexactinellids, Marshall withdraws his opinion as to the continuity of the axial canal system in the framework of *Sclerothamnus*, and thus abandons the group of synauloid Hexactinellids.

In 1880,[2] O. Schmidt discusses these systematic questions in detail. He says (p. 41) that "the conception which one is apt to associate with the division of the Hexactinellids into Dictyonina and Lyssacina, namely, that each group for itself has originated from one or several common ancestral forms, and that all the Dictyonina, and especially the recent forms, are more closely related to one another than to the Lyssacina, is certainly not in accordance with the facts. The relation between these two divisions appears indeed to be much closer; the phylogenetic branches have probably repeatedly crossed, and are interlaced by connecting twigs. In one of the new genera, *Hertwigia*, this insepar-able relationship is expressed in the most convincing way, since this sponge at the branched base is distinctly dictyonal, but forms further up, where it consists of irregular tubes and plates, a transitional type, and finally, still further up and towards the exterior,

[1] *Mitth. a. d. k. zoolog. Mus. Dresden*, 1877. [2] Spongien des Meerbusens von Mexico.

exhibits a beautiful Lyssacine structure. The same transition is exhibited by *Rhabdodictyum* and *Rhabdostauridium*."

"At any rate the Lyssacina were once the sole representatives of the Hexactinellida. As a Lyssacine every Dictyonal form must still begin its development, though this stage may only perhaps last for a very short time. And thus there was at any stage the possibility of the Dictyoninal form becoming again reduced to a Lyssacine. The stiffest and most brittle Dictyoninal framework differs after all only in degree from that of the loosest of the Lyssacina."

My own researches have convinced me that there is indeed a certain antithesis between Lyssacina and Dictyonina, which may be justly recognised in the distinction of these two systematic divisions of the order Hexactinellida, but that this difference is not fundamental, nor involving the separate origin of the two divisions, but that it is rather one of degree and in no way suggesting a hard and fast separation.

In distinguishing the two groups, Zittel laid stress, however, not merely on the simple fact whether the principal spicules were or were not united into a firm connected framework, but rather on the *manner* in which this union was effected. It must be allowed that what is regarded as the characteristic dictyonal mode of framework formation, viz., by close apposition of the two corresponding arms of adjacent hexradiate spicules, and the formation of a common sheath, is indeed very frequent, and in some Dictyonina, like *Aulocystis*, or in the youngest portions of *Farrea* stocks is even normal or perhaps constant, but it cannot be overlooked that it is extremely common to find that the mode of union of the dictyonalia is in part, or here and there throughout, essentially different. Zittel indeed called attention to the fact that beside the hexradiate spicules united as above indicated there were others "which left the series and had their rays soldered arbitrarily to the rest of the framework. When one or two rays of such irregularly disposed spicules become united by chance to the thickened centre of a hexact, the result is obviously the apparent origin of more than six rays from one centre of intersection. Other irregularities may also arise by the curvature or direction of individual rays, so that two rays in one axis come to lie no longer in a straight line." If these deviations, which may be readily detected in most Dictyonina, are really only exceptions to the typical mode of union which Zittel supposed to obtain, then the sharp and certain separation of the Dictyonina from the Lyssacina with connected framework cannot be said to be seriously affected. But there are, besides, not a few Hexactinellida in which the supposed typical mode of union is either not to be detected at all, or only here and there after careful search, and even then in a fashion so far from characteristic that among the countless deviating and arbitrary intersections of the majority of the rays the exceptional occurrence of the typical mode may be indeed regarded as a matter of chance. Thus, for example, in the different species of the genus *Aphrocallistes* known to

me, the typical union of the dictyonalia is wholly absent, although no one has any doubt that *Aphrocallistes*, in the general structure of its skeleton, and especially in the structure and disposition of its isolated spicules, belongs to the Dictyonina, and is to be referred to the neighbourhood of Euretidæ and Coscinoporidæ. As an instance of the second case, where a skeleton which is macroscopically like many dictyonal frameworks contains only isolated examples of two hexradiate spicules uniting in the typical fashion, I may refer to *Euryplegma auriculare*.

In regard to this form I have indeed hesitated for a long time whether I should refer it to the Lyssacina or to the Dictyonina. At first, in my memoir Ueber den Bau und das System der Hexactinelliden,[1] I regarded it as a Dictyonine, but have finally preferred to place it among the Lyssacina, and beside the Rossellidæ, which, both in regard to the structure of the loose needles and the absence of uncinates, it resembles more closely than it could any Dictyonine form. In its other characters it is, however, Dictyonine-like, though the absence of uncinates and scopulæ give it a peculiar appearance and must always make its position exceptional.

It was a fact of much interest to me that my respected colleague Professor Zittel unhesitatingly referred a macerated skeleton of *Euryplegma*, which I asked him to examine in the Berlin Zoological Institute, to the Dictyoninal type, while allowing that various microscopical sections of the same skeleton completely resembled the Lyssacina in the spicular union of the framework.

There are, indeed, other distinctive characters between Lyssacina and Dictyonina than the mode of union of the spicules, but these also establish, not a fundamental separation, but only a difference of degree. Previous investigators have noted the readily verified fact that in all emphatically Lyssacine types, which form a connected skeletal framework, there occurs, besides the simple soldering of the spicule branches, another very frequent mode of union by means of short connecting bridges, the so-called synapticula, which bind together more or less approximated rays of adjacent spicules, which are not, however, in actual contact. By the development of numerous synapticula at approximately uniform intervals, there arises a scalariform structure, which is regarded by some as characteristic of the Lyssacina with connected framework, and as contrasting them with the Dictyonina. But while it is indisputable that such scalariform structures occur with great frequency, indeed quite regularly in the framework of Lyssacina, it is incorrect to assume that they are absent from all Dictyonina. I have observed them, though not frequently, yet quite typically developed in indisputable Dictyonina, such as *Fieldingia lagettoides*, S. Kent, which in its uncinates and scopulæ is certainly one of the Dictyonine series.

Another fact, to which I first called attention, is the early union of the dictyonalia simultaneously with the development of the associated portion of the body, which is, so

[1] *Abhandl. Königl. Preuss. Akad.*, 1886.

far as we know, a contrast to the subsequent, and late union of the various spicules in certain Lyssacina. In the latter it is deferred till after the differentiation of the body has made considerable progress, and then only gradually develops from a given centre in the already perfected body.

But although I regard this difference as most conveniently diagnostic of the two groups, I must allow that it also represents only a qualitative difference. The dictyoninal spicules of the Dictyonina were once, as Marshall first clearly demonstrated for *Aulocystis zittelii*, free spicules, and the union gradually progresses from the younger to the older portions of the body. We also know of many Lyssacina with connected skeletal framework, like *Rhabdodictyum delineatum*, O. Schmidt, *Aulocalyx irregularis*, F. E. S., and especially the above-mentioned *Euryplegma auriculare*, F. E. S., in regard to which we are by no means certain, whether, as in species of *Euplectella* and some other Lyssacina, the process of fusion or the formation of synapticula take place some time after the differentiation of the sponge-body, or shortly after its incipient formation. In regard to those Lyssacina in which an abundant fusion of spicules forms a compact base attached to solid bodies, it is very probable that the fusion of the spicules begins somewhat early at the lower end, and progresses gradually upwards to the upper margin. The upper end of many Lyssacina with latticed framework has been long since carefully described, as O. Schmidt has done for his *Hertwigia falcifera* and other Hexactinellids, and known to consist solely of loose isolated spicules, while the lower end exhibits a well-developed fusion.

We thus see that the relation at present demonstrable between extant Lyssacina and Dictyonina does not suggest a long-established separation of the two groups, but rather a gradual modification of certain Lyssacine groups into Dictyonina, while others have remained at the undoubtedly older Lyssacine stage.

We do not, indeed, know the development of the Dictyonina, but it is to be expected that they possess at first only isolated spicules, and recapitulate probably for a short time the Lyssacine stage, before a regular fusion of hexacts occurs, and the typical dictyonal characteristics set in.

It appears to me further a very noteworthy fact that the results of my bathymetrical statistics show that the Lyssacina occur predominantly in the greater depths and far from the coast in Mid Ocean, while the Dictyonina are chiefly found in moderate depths and near the coast. The Hexactinellids of the Challenger Expedition, which were obtained from the greatest depths belong to the simplest and most typical Lyssacina, as for example certain species of *Holascus* and *Bathydorus*, especially *Bathydorus fimbriatus*, which was dredged in Mid Pacific from a depth of 2900 fathoms.

Furthermore, in some species of certain Lyssacine families, such as Euplectellidæ and Rossellidæ, we find in the very irregular and long deferred fusion of the larger spicules into a compact connected framework, what may be regarded as an incipient development of a dictyonal skeleton.

The dictyonal character is, therefore, regarded as acquired, by some groups in the far past, by others at a later stage, while many do not in any way exhibit it. Thus we may explain that in former epochs Dictyonina and Lyssacina are found to have occurred together as they now do.

If we now take a survey of the various main and side branches of the hypothetical genealogical tree of the Hexactinellids, so far as that can be sketched out from the results of living forms, we are at once brought to face a deep division, affecting both soft parts and skeleton, between the Amphidiscophora or Hyalonematidæ on the one hand, and all the rest of the Hexasterida on the other.

While in the latter the membrana reticularis, which is doubtless so important in relation to the nutritive process, appears to form throughout appproximately equal thimble-shaped chambers, longitudinally apposed to one another, in the Hyalonematidæ it is more or less irregular in its contour, and forms chambers not so sharply separated and without any typical structure and of approximately equal size. It seem to me that this peculiar condition of the membrana reticularis in the Hyalonematidæ perhaps suggests a relatively lower grade of differentiation, and is at any rate a not unimportant deviation in the general structure, which otherwise closely resembles the other Hexactinellida. But the Hyalonematidæ are yet more distinctly separated from the others in the constant and peculiar possession of the siliceous elements known as amphidiscs (or birotulæ), as also in the complete absence of hexasters which occur in all the other Hexactinellids. While these facts point to a marked independence of the Hyalonematids, and to a distinct separation from all other Hexactinellids, there are also certain other characters which occur with great constancy and uniformity within the whole group, but less so in other divisions. Thus we note the constant mode of attachment in the muddy bottom by means of a basal tuft, and the way in which the entire outer surface is covered with pinuli.

One cannot therefore but suppose an early separation and an independent development of the Hyalonematidæ or Amphidiscophora, as is represented in the genealogical tree by the deep cleft separating this important and at present richly developed branch from the other Hexactinellids.

Among the other Hexactinellids, which are without amphidiscs but contain hexasters, and may therefore be conveniently designated as Hexasterida, one group of families distinguished by the presence of uncinates may be somewhat sharply separated off from the others. These Uncinataria are all Dictyonina, and have apparently at an early stage separated into two divergent branches, namely, on the one hand, the small, but sharply defined family of Farreidæ, distinguished by the single-layered structure of their square-meshed lattice-work in its youngest growths, and also by the exclusive possession of the remarkable clavulæ in their limiting membranes; and, on the other hand, the Scopularia, which exhibit in their scopulæ spicules so peculiar and charac-

teristic that one can hardly find a more striking proof of close relationship. Of less importance, though in detail often not without striking peculiarities, are the characters which distinguish the four living families of Scopularia. Thus, for example, the family of Melittionidæ, though including only the single genus *Aphrocallistes*, with a few species, is so sharply defined and removed from the other families by the hexagonal, prismatic, honeycomb-like radial perforations of its flat dictyonal framework, that one must assume a long, independent, ancestral series, that is to say, a somewhat early separation of the twig from the common branch of the Scopularia. The characters of the primitive portion of this branch appear to me to be represented in their least modified form by the family of the Euretidæ, where the structure is comparatively simple and slightly differentiated, especially in regard to the afferent and efferent canals penetrating the body-wall. For while in the Euretidæ the afferent and efferent canals, which traverse the thin wall of the tubes forming the entire sponge, are quite short and usually sack-shaped, of simple uncharacteristic form, the efferent canals of the Melittionidæ are straight, hexagonal prisms, those of the Coscinoporidæ straight, narrow, and usually long, alternating funnels penetrating the body-wall at right angles, and those of the Tretodictyidæ, finally, are of irregular course. And as to the other Hexasterida which contain no uncinates, the family of the Mæandrospongidæ, which flourished in the Cretaceous period, is distinguished by the structure of the body, which consists of a system of anastomosing, meandering, thin-walled tubes, with an interjacent system of anastomosing canals.

But while these Mæandrospongidæ have long since become true Dictyonina, the other families of Hexasterophora, without uncinates, have either entirely preserved the Lyssacine character, or they nearly approach the Dictyonine type by the more or less marked soldering of the larger spicules into a connected framework, which develops with increasing age. Of the three families—Euplectellidæ, Asconematidæ, and Rossellidæ, the first has a markedly separate position, due to the hexradiate character of the spicules supporting the skin (hypodermalia), while the others exhibit only pentact hypodermalia, with an internal radial ray. While in the Asconematidæ autodermal pinuli are also developed within the skin, giving to this Hexasterid family a very peculiar character somewhat resembling that of the Hyalonematidæ, in the Rossellidæ such autodermalia, with a freely projecting fir-tree-like ray, do not occur. It is difficult, if not indeed impossible, to determine, with any certainty, the relationship of these three allied families. It is obvious that the Euplectellidæ, both in their relatively simple, saccular or tubular form, and also in their hexradiate dermal spicules, have retained primitive characters, so that one need not wonder that very simple related forms are found at a comparatively early period. On the other hand, both in the parenchyma of several species, such as *Dictyocalyx gracilis*, and also in the extremities of the dermal projections of many genera, *e.g.*, *Euplectella*, *Tægeria*, *Walteria*, &c.,

very complicated, highly differentiated spicules (discohexasters, floricomes, &c.) occur, and so many species incline towards fusion of the large spicules and formation of a connected framework, that one cannot regard these forms at least as primitive.

A very simple structure is exhibited by certain tubular or saccular Rossellidæ, as for instance, *Bathydorus fimbriatus*, from the great depths. On the other hand, there are species, like *Aulocalyx irregularis*, which, both in the formation of a connected supporting framework, and in the complicated structure of the isolated spicules, occupy a decidedly higher grade. Such are the members of the entire division of Cratero-morphinæ, in which a more or less firm long stalk is formed, and the chamber-layer exhibits a complicated folding. The Asconematidæ exhibit a remarkable affinity with the otherwise indisputably far-removed Hyalonematidæ, in the possession of autodermal pinuli. Here there can hardly be any direct inheritance, either of one family from the other, or of both from a common ancestor. I am rather of opinion that the tendency to form lateral teeth is very generally distributed among Hexactinellid spicules, and is expressed in development whenever such would be physiologically advantageous or specially useful for the preservation and strengthening of the organism, as for instance in the formation of weapons of capture or defence on the autodermalia projecting from the skin. I believe that the tendency may be expressed in far-removed Hexactinellids, without there being any transmission by inheritance. And this opinion is supported by the fact that, among the typical Scopularia, there are isolated cases in the various genera and species, *e.g.*, in *Aphrocallistes* and again in *Chonelasma dœderleinii* (but not in *Chonelasma lamella*), in which the distal radial ray of the hypodermalia, projecting more or less beyond the skin, exhibits exactly similar teeth, and thus most distinctly evidences the formation of a pinule.

In the following sketch of a genealogical tree, including those Hexactinellids which I have investigated, the opinions above expressed are graphically represented.

When an attempt is made to collate the results of the investigation of living Hexactinellids with what is known of fossil forms, an array of difficulties beset the task. Above all it is unfortunate that of the great majority of fossil forms only the dictyonal framework is known, so that there is no possibility of induction as to the configuration of the soft parts, nor as to the form, number and disposition of the isolated skeletal elements which are so pre-eminently characteristic, and so extremely important, in spite of Zittel's opinion, in determination of relationship. Again, the blanks in the geological record are here even more serious than in most of the other groups. From entire geological formations either no Hexactinellids are known, or only slight traces. Zittel indicates an obvious explanation in the following sentences:[1]—"Our knowledge of the fossil Hexactinellids is limited to isolated remains of a developmental series, widely separated (both in time and space) the links of which perhaps lie buried in the deposits now sunk

[1] Palæontologie, i. pp. 199, 200.

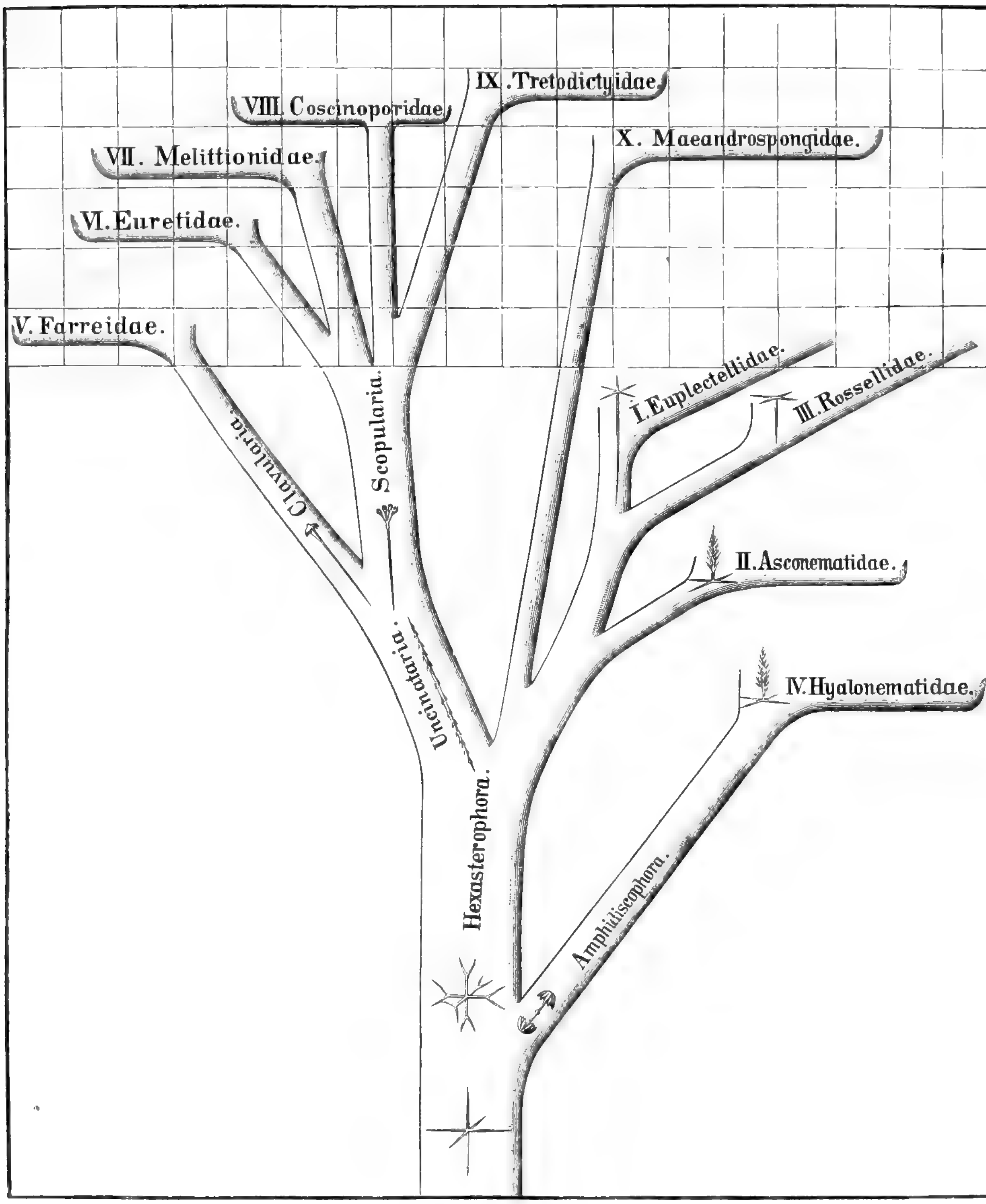

FIG. 8.—Genealogical Tree of the Hexactinellida.

beneath the sea-level, or in still unexplored regions. Under these circumstances it is not yet possible to construct a genealogical tree for the various genera, so we must dismiss to a pre-Silurian time, where the light of experience no longer guides us, all the hypotheses which would derive the Hexactinellida from the Tetractinellida or Monactinellida."

An explanation of the sudden appearance of the fossil Lithistidæ and Hexactinellida may be reasonably sought in the mode of life exhibited by their modern representatives. Both groups are especially inhabitants of the deep-sea, and only in the former deep-sea deposits can one hope to find their fossil remains in any abundance.

If therefore we have to refer the origin of the Hexactinellida to a pre-Silurian period of which no certain representatives are preserved, we cannot obviously expect from palæontology any conclusion as to the manner of their origin or the nature of the primitive forms. It is, however, of importance, that even in the Silurian period both Lyssacine and Dictyonine forms appear to be present. In the later mesozoic formations which are so rich in Dictyonina (especially the Jurassic and Cretaceous), hardly a hint of Lyssacina is to be found, while now they form among living forms a large majority—a fact which appears to find its explanation in the improbability of the preservation of forms with a loose spicular framework which would fall to pieces with the destruction of the soft parts. The following considerations may, however, appear not unworthy of close examination.

From the fact that the modern Hexactinellids all live at a considerable depth, always below 95 fathoms, Zittel has already drawn the conclusion that they were probably from the first deep-sea forms.

From the bathymetrical statistics of the Challenger Hexactinellida, it is seen that the Hexactinellids now living in the greater oceanic depths are almost exclusively Lyssacina, and that the modern Dictyonina are, with the exception of one very simple genus, all confined to the relatively lesser depths, between 100 and 1500 fathoms. The conclusion, therefore, seems warranted, that in ancient times also the Lyssacina predominantly occurred in the greater depths, while the more differentiated Dictyonina inhabited, as they now do, relatively shallower waters, at no very great distance from the coasts. Now if one may assume that the deepest regions of the great oceans have remained permanently covered with water since the Palæozoic period, while only the shallower regions near the continents were here and there raised above water, and thus became now accessible to the hammer of the palæontologist, we can understand why we find in certain Jurassic and Cretaceous deposits so many and highly differentiated Dictyonina, but only slight hints of Lyssacina, even in circumstances which would not exclude their preservation, or at least that of their characteristic spicules.

Hitherto I have restricted myself to the Hexactinellida themselves; I shall now consider their relation to the other groups, beginning with the calcareous sponges.

It may be assumed as a generally acknowledged fact that the calcareous sponges are

distinguished as a separate group, not only in the substance out of which the skeleton consists, but also in the form of the component spicules.

One is therefore inclined to suppose their very early divergence from the great sponge stem. On the other hand, the marked uniformity of their skeletal elements lead one to suppose that they have had a common starting point, *i.e.*, a monophyletic origin. This supposition is confirmed by the certain fact that the Sycones in their ontogenetic development pass through a distinct Ascon stage, and that between the Sycones and Leucones recent investigations have discovered many connecting links, as has been shown especially in the Challenger Report on Calcareous Sponges by Polejaeff, and von Lendenfeld's researches on Australian forms.

A closer relationship connects the siliceous, horny and soft sponges. In regard to the last I have previously shown, that both on account of the incongruity between the different members of the group, and the obvious relationship between certain forms and indisputable horny and flinty sponges, the group cannot be regarded as independent, closed and natural, but must be split up and its members referred to different positions on the genealogical tree near their various congeners, and regarded as twigs degenerate in respect to their skeleton.

In regard to the horny sponges there seems to me no other supposition possible, but that of regarding them as originating from flinty or flinty-horny sponges by the gradual reduction and final disappearance of the siliceous spicules.

The more abundant and differentiated the horny substance the more degenerate the flinty skeleton, until finally, as in many Chalinidæ, which approach the true Keratosa, we find only very simple smooth spindles, which I am compelled to regard as the extreme of the phylogenetic series of siliceous spicule modification.

In my memoir on the family of Plakinidæ, I have shown in detail why it is that in the long and continuous series of transitions between the typical regular tetracts and the simple straight spindles, exhibited both in individual species and often in one individual, as well as in the skeletons of nearly related species, it is impossible to regard the straight spindle as the primitive form from which the triacts and tetracts have been formed by the growth of new rays, but necessary to regard the tetracts as primitive and ancestral, from which the triacts and diacts have arisen by atrophy and degeneration of the various rays. Oscar Schmidt[1] was led to the same conclusion by a detailed investigation of other Tetractinellida, and especially of the Ancorinidæ, where it may be very readily seen how gradual reduction of the typical tetracts, only modified into anchors by the elongation of one ray, leads finally to simple rod-like spicules, and further how within those genera, which, like *Caminus*, have acquired rod-like spicules, degenerate anchors here and there persist, showing the mode in which the rods have originated from tetracts.

[1] Entstehung neuer Arten durch Verfall und Schwund alterer Merkmale, *Zeitschr. f. wiss. Zool.*, Bd. xlii. p. 639.

I may therefore regard it as indubitable that in many cases the regular and typical tetracts have, by gradual reduction of individual rays, given rise to diacts and even monacts. I do not mean to say that all diacts and monacts have originated in tetracts. On the contrary, previous investigators of the Hexactinellida have shown, what I think I have also clearly demonstrated, that in this group at least the very abundant and richly developed diacts and monacts have arisen, not from the regular tetracts of the Tetraxonia (the so-called chevaux de frise), but from the regular hexacts of the Triaxonia. But while there are numberless extant transitions from the Tetraxonia with typical tetracts to the strict Monaxonia with only straight diacts or monacts, there are among living, and, so far as I know, among fossil sponges no transitions from the Triaxonia to strict Monaxonia, so that we have no reason for the supposition that the latter have been evolved from the former. The case is somewhat different in regard to some sponges without a skeleton, lately discovered in Australia by von Lendenfeld (such as *Bajalus*[1]) in which the structure agrees so closely with the soft parts of several Hexactinellids that one is inclined to suppose their derivation from the latter by a total loss of siliceous spicules.

Under these circumstances, the supposition is legitimate, that all the Monaxonia, and the Keratosa which have probably developed from them, have originated from the stem of the Tetraxonia. And since the spicules of the Lithistidæ, as O. Schmidt, Zittel, and others have conclusively shown, are derivable from the regular tetract type, we may thus regard the Tetraxonia with simple regular tetracts as the starting point for all the flinty and horny sponges except the Hexactinellida.

For the possibility that the Hexactinellida also stand in genetic relationship with the Tetraxonia, I find no basis of facts. In 1870 O. Schmidt[2] expressed the same opinion in the following words:—"Between the type of spicule in which the rays are determined by the three-sided pyramid and the triaxonial type, there are, so far as the forms go, no relations. The sponges in which these two types occur appear to be distinct and separate independent twigs, in regard to which one must distinguish clearly between the general homologies and the adaptive analogies."

We thus reach this conclusion, that the sponges may be grouped along three main stems, which may indeed be regarded as springing from a common root—a very simple primitive sponge without a skeleton—but which remain separate from this root onwards, without exhibiting any connecting links.

This may be expressed in the form of a genealogical tree (see fig. 9).

Now if we may regard it as probable that each of these three main stems, which represent the divisions of the great crowd of sponges, namely (1) Calcarea, (2) Tetraxonia with Monaxonia and Keratosa, and (3) Triaxonia, possessed to start with, either exclusively

[1] *Proc. Linn. Soc. N.S.W.*, vol. x. p. 5.
[2] Grundzüge einer Spongienfauna des atlantischen Gebietes, 1870, p. 5.

or predominantly, that form of skeletal element from which the rest have developed, we must, after determining this fundamental form, strive to understand why in each individual stem the specific form of spicule must be what it is.

In regard to the calcareous sponges, Haeckel expresses, in his epoch-making monograph, the conviction, based both on anatomical and embryological facts, that the fundamental and primitive form of all calcareous sponge spicules is the regular triradiate form, and in association with that, perhaps, though less widely distributed, the simple rod-like form. But by "regular triradiate" Haeckel means a three-rayed spicule, in which the rays, perfectly similar in size and form, meet at equal angles of 120°, and all lie in one plane. Haeckel[1] shows that even yet the triradiate spicules are throughout the firm supports of the body, while the tetracts occur as the protective weapons of the gastral surface, or the rods of the dermal; and he draws the conclusion "that the triradiate forms originally and primarily played the principal role, while the four-rayed spicules first arose only as internal adaptive modifications on the gastral surface, and the rod-like forms as external and therefore secondary differentiations."

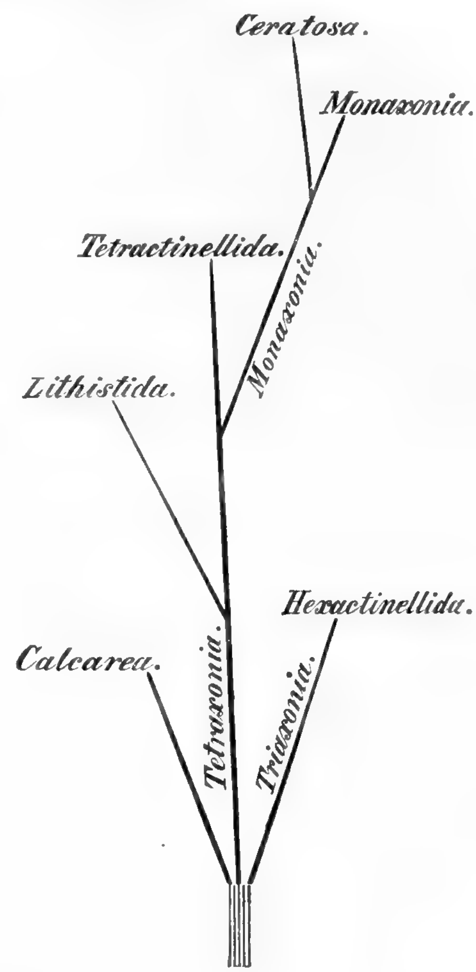

Fig. 9.—Genealogical Tree of the Porifera.

As of special importance in regard to the formation of this specific form of spicule (triradiate) in the soft parts of the primitive calcareous sponges, Haeckel notes (p. 377) a peculiar process of "biocrystallisation, *i.e.*, a compromise of the crystallising tendency of carbonate of lime and the organic processes of the protoplasm." The calcareous spicules of the Calcispongiæ are, according to Haeckel, to be regarded as "biocrystals or form-individuals occupying a median position between an inorganic crystal and an organic secretion, and in their origin expressing a compromise between the crystallisation of carbonate of lime and the formative activity of the fused cells of the syncytium." "The original and fundamental form of all three-rayed and four-rayed spicules is the absolutely regular triact, which may be considered as a hemiaxonial form of the hexagonal crystal system, in which the carbonate of lime crystallises as calc-spar."

[1] *Loc. cit.*, Bd. i. p. 352.

O. Schmidt has also occupied himself with the notion of explaining the form of the typical sponge spicules in terms of the crystallising tendencies of the different substances. He says: "The question is a difficult one, how far the nature of the lime and the flint determines the rayed and anchor-shaped forms related to the three-sided prism. For the flint the explanation holds good, but not for the lime. But while in the group of triaxial siliceous spicules (hexacts and their derivatives) we have only to choose between the triaxial and the binaxial and monaxial system, and the hexagonal does not come into account, we must remember the fact, inconvenient to mineralogists, that quartz crystals arising in amorphous matrix not unfrequently exhibit axial deviations from the hexagonal system, and that we may the more readily expect in our sponge spicules with organic basis and admixture other forms than those of the crystallógraphic systems." [1]

For my own part I must pronounce against such an attempt to bring the form of the sponge spicules, whether they consist of carbonate of lime or hydrated silica, into relation with the crystallising tendencies of these substances in the way of origin or explanation. In the first place, in regard to the siliceous spicules, the fact has to be noted that the silica in them never occurs in a crystalline state, but is always present as completely amorphous hydrated silica or opal, as is shown, for instance, by the fact that they are not doubly but only simply refractive. This is therefore against the supposition that the various skeletal elements can be reduced to or derived from the crystallisations of the substances of which they consist. Furthermore, we cannot ignore the extraordinary abundance and frequent importance of the deviations of the rays from the typical angle at which they ought to stand to one another, nor does the marked curvatures of the rays accord with the supposition of defined crystalline axes.

I must rather maintain that the form of all the sponge spicules is determined by the organic matrix in and from which they originate, and that the formative forces are in no essential way different from those which are everywhere exhibited in the shaping of the living organism and its parts.

And though we still know very little about the forces determining form, yet in these skeletal formations it is possible here and there to detect factors which, though they do not indeed explain everything, yet make much at least more intelligible.

If one can distinctly demonstrate a natural and necessary connection between the form and disposition of a skeletal element and the function which it discharges, one has, from the standpoint of utility and natural selection, rationalised the appearance of that form and disposition.

In regard to the question why the typical and primitive spicule in the calcareous sponges should be the plane, regular, triradiate form, in the Tetraxonia with their

[1] Grundzüge einer Spongienfauna des atlantischen Gebietes, p. 4.

derived allies the Monaxonia and horny sponges the regular four-rayed form (spanische Reiter), and in the Triaxonia (Hexactinellida) the regular six-rayed spicule, it seems to me of essential importance to note the difference of the architecture of the soft parts in these three principal groups.

The Ascones, which may be regarded as the starting group in the calcareous sponge series, exhibit, as is well known, in the simplest instance, a fixed thin-walled tube open at the free end, and with its side wall penetrated by uniformly distributed circular pores.

In the much-varied group of Tetraxonia and their descendants we may consider the typical form as that of a thick-walled cup, in the compact wall of which roundish or quite spherical ciliated chambers lie crowded together like the acini in an acinose gland. Such at least are most of the Tetractinellida and Lithistida, numerous Monactinellida and horny sponges, though deviations also occur, as in the flat crusts of many Plakinidæ, which can hardly be regarded, however, as typical or primitive forms.

The typical structure of the Hexactinellida is very different.

The exceedingly loose wall of the typically sack-shaped body exhibits, between two abundantly penetrated, thin, parallel bounding lamellæ, a single layer of large, sack-shaped, ciliated chambers, connected both with the outer dermal and inner gastral membrane by a trabecular system of thin thread-like strands. In simple and young forms these thin connective-tissue trabeculæ run predominantly in a radial direction between the chamber-layer and the two limiting lamellæ, or directly between the latter, and are usually so closely united with one another by tangential uniting strands that one usually observes six threads at right angles to one another at each node of intersection. This simplest structure is not of course persistent throughout. And in many cases, doubtless, the insufficient preservation of the soft parts does not permit of the recognition of the original disposition of the trabeculæ.

Let us now consider how the spicules, regarded as typical and primitively characteristic, are disposed in the very variously constituted tissue of these three divisions of sponges.

The regular three-rayed spicules of the Ascones are well known to occur tangentially embedded in the wall of the tube, and in such a way that one ray lies parallel to the axis directed backwards towards the base, while the two others run obliquely forwards and to the side, each usually embracing a parietal pore posteriorly.

In the Tetraxonia the typical regular tetracts lie in their simplest and most normal form between the spherical ciliated chambers, while, as a rule, the regions without chambers, viz., the margin, basis, and neighbourhood of the large canals, contain more or less markedly differentiated spicules.

In the Triaxonia (Hexactinellida), finally, the typical regular hexacts are found almost exclusively in the strands of the trabecular framework, while in the chamber-wall

no spicules occur, and only much modified elements in the two limiting lamellæ, the basis, the oscular margin, &c.

If we assume that the spicules in the body-wall serve essentially only for the support or stiffening of the soft parts, it is to be expected that that form and disposition of the skeletal elements will in each case be developed which in the given circumstances is best fitted to give the necessary firmness to the body-wall.

I am decidedly of opinion that it can be shown with convincing probability that such a necessary relation does exist between the structure of the soft parts in each of the three principal groups of sponges and the characteristically typical forms of spicule

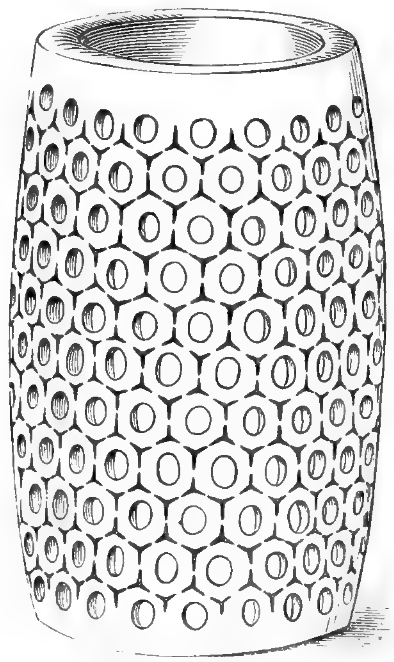

FIG. 10.—Triacts with each of the three rays lying at a uniform angle between two adjacent pores.

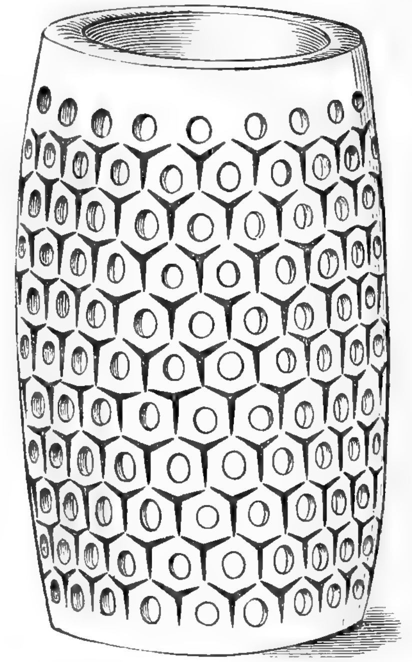

FIG. 11.—Triacts disposed so that half of the interspaces are occupied by their central portions and the other half by their convergent rays.

which we regard on anatomical and developmental ground as primitive and fundamental for each group.

If a plate is to be perforated by the maximum number of uniformly large spherical pores in such a way that the lumina of the pores have a certain scope for expansion or contraction, these pores can only exhibit one definite mode of arrangement, namely, that of the cells of a honeycomb, and will leave a network with somewhat broad beams between them.

If the plate consist of a mass which requires to be supported by the deposition of hard parts, and if these are, on the one hand, to preserve the maximum of firmness, and on the other to allow of a certain degree of expansion both to the entire tube and also to the

interjacent pores, then the triradiate spicule is the fittest form. These can be distributed in such a way that each interspace between three adjacent pores is occupied by a regular triact with each of the three rays lying at uniform angle between two adjacent pores (fig. 10), or they may be disposed so that only half of the interspaces between the pores are occupied by the central portions of the triacts, while the other half contain the points of convergence of the extremities of three rays of three adjacent triacts (fig. 11). This latter mode is exhibited by numerous very simple calcareous sponges of the Ascon type. For the case of an open tube, fixed at one end, and with the other (oscular) extremity free, careful consideration will show that the latter mode of disposition is the most advantageous. In this way the boundary of each pore, especially on the lower margin, is strengthened by the forking of the triact which embraces it posteriorly, and the whole sponge-tube is better strengthened by the relatively longer spicules than it would have been on the former plan. We may therefore regard the development of the regular triact as that conditioned and demanded by the structure of the soft parts of the primitive calcareous sponges.

In regard to the Tetraxonia, with their regular tetracts, I submit the following consideration. When a number of spheres of equal size are uniformly pressed together on all sides, they become disposed to one another in such a way that between each four adjacent and directly contiguous spheres a regularly formed cavity is left, which is continued in four three-sided clefts disposed at a uniform angle, and is thus connected with the adjacent interspaces of similar form. One can best compare the form of these spaces to regular tetrahedra with inpushed walls and drawn-out angles, which pass into the similarly elongated angles of adjacent tetrahedral spaces, and thus secure the connection of all the cavities. Now, if one supposes this entire system of cavities to be filled with a semi-solid mass, and the spheres to be empty spaces, there is an obvious necessity for a supporting framework. And if the skeletal system necessary for the support of this framework consists of uniformly movable skeletal elements with cylindrical branches, then each of these bodies must necessarily have its centre in the middle of each tetrahedral mass between each four adjacent hollow spheres, and from this centre four strands must run out along the four elongated angles of the tetrahedron.

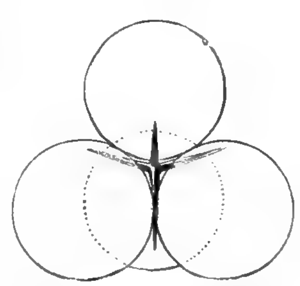

Fig. 12.—Tetract spicule in contact with four spheres.

The best supporting element for such a mass is afforded by such regular tetracts as we find in the similarly constituted parenchyma between the ciliated chambers of Tetraxonia, and known to be typical for this group of sponges.

Although the almost wholly unknown development of the Hexactinellida gives us as yet no basis for framing a conception of the architecture of the primitive Hexactinellida, it is possible, from the close resemblance in the essentials of structure exhibited

by all the known representatives of the group, to conclude that the primitive ancestors must have had a similar structure, though in very simple form.

As I have already noted, the generally sack-like, extremely loose body consists essentially of two approximately parallel bounding lamellæ, the dermal and the gastral membranes, between which there extends the variously sinuous membrana reticularis, usually forming a folded chamber-layer, and supported by a framework of fine beams. The principal strands of this trabecular framework enclosing the parenchymal skeleton extend at right angles from each of the two limiting lamellæ, and usually meet one another in such a way that they form beams penetrating the body-wall transversely, while they are also laterally connected by numerous trabeculæ, which, running in another direction, form a somewhat irregular framework, though longitudinal and transverse strands predominate.

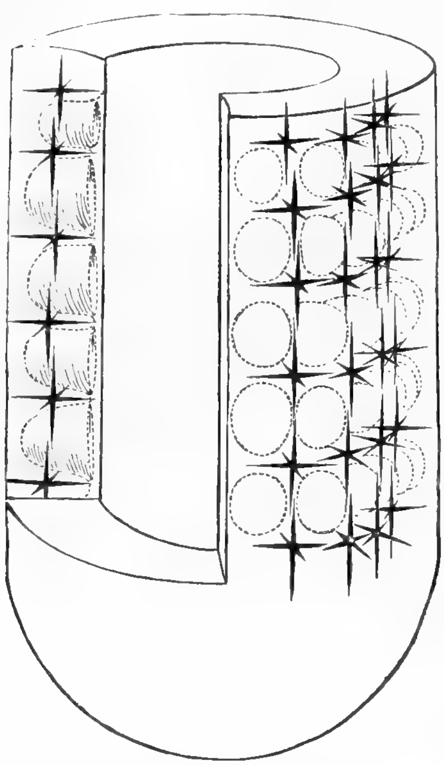

FIG. 13.—Arrangement of Hexacts between the chambers.

It thus appears to me evident that, in these circumstances, no more advantageous form of spicule for the support of such a simple, loose Hexactinellid body, could be devised than the regular hexacts, disposed in such a way that one radial ray unites the two bounding lamellæ, while the second is tangential, and the third longitudinal (fig. 13), just as they do indeed occur in the simplest Lyssacina, *Holascus*, *Bathydorus*, &c.

By the firm union of all such hexacts a lattice-work is formed such as we find to be developed with almost ideal regularity in the younger portions of *Farrea*. As the wall becomes thicker new layers of similar regular hexacts are laid down, as we find best developed among the Lyssacina in *Holascus fibulatus*, and among the Dictyonina in the older portions of *Farrea*-stocks, but more or less distinctly in all Dictyonina and most Lyssacina.

Thus it appears that a consideration of the mechanical conditions of the soft parts to be supported affords in this case also an insight as to the utility of the specific structure of the skeletal elements as here represented by the regular hexacts.

INDEX.

The more important references are indicated by heavier figures.

POSTSCRIPT.

Balanites, *Polyrhabdus* and *Polylophus* are preoccupied as generic names. I propose, therefore, to substitute *Balanella* for *Balanites*, *Pleorhabdus* for *Polyrhabdus* and *Lophocalyx* for *Polylophus*.